Sun®

PERFORMANCE ANALYZER

OPERATOR'S MANUAL

PERFORMANCE ANALYZER
SUN 1115
OPERATOR'S MANUAL

PERFORMANCE ANALYZER
SUN 1115
OPERATOR'S MANUAL
TABLE OF CONTENTS

GENERAL INFORMATION

Operator's Manual 1
Tester Information 1
Head Sign 1
Analog Oscilloscope 1
Reading Dwell On Scope 2
Scope Control Panel 2
Function Selector 2
Pattern Height 2
Variable Adjust 2
Pattern Selector 2
Pattern Position 3
Five Pattern Adjustment Controls 3
Cylinder Select Mode 3
Center Panel Controls 4
Engine Kill Button 4
Cylinder Selector 4
Cycle Selector Buttons 5
Amperes-Dwell-RPM Control 5
Amps Calibration Control 5
Ignition Selector Control 5
Number Of Cylinders Control 5
Right Panel Controls 5
Volt-Ohm Control 5
Ohms Cal Control 5
Hydrocarbon Zero And Span 5
Carbon Monoxide Zero And Span 6
Hydrocarbon High And Low 6
Carbon Monoxide High And Low 6
Infrared Test Selector 6
Meters And Indicator Lights 6
Low Flow Indication 7

AREA TESTING PROCEDURES

Area Testing Procedures 9
Tester Preparation 9
Position Scope Controls 9
Position Tester Controls 9
Calibrate HC And CO Meters 10
Lead Connections To Vehicle 10
Testing Procedure 11
Test 1 — Cranking Tests 11
Test 2 — Charging Tests 11
Test 3 — Idle Tests 11
Test 4 — 1200 RPM Low Cruise 12
Test 5 — Cylinder Power Balance 12
Test 6 — Snap Acceleration 12
Test 7 — 2500 RPM High Cruise 12

ANALOG SCOPE TESTING

Analog Scope Ignition Testing 13
Initial Setup 13
Standard Ignition Testing 13
Test Lead Connections 13
Interpreting Scope Patterns 13
The Firing Section 14
The Intermediate Section 14
The Dwell Section 14
Primary Circuit Interpretation 14
Primary Firing Section 15
Primary Intermediate Section 15
Primary Dwell Section 15
Programming Scope Controls 15
Display Pattern 15
Raster Pattern 17
Superimposed Pattern 17
Vehicle Testing 18
Coil Output Cranking 18
Coil Polarity 18
Ignition Secondary And Spark Plug Firing Voltages (Min And Max.) 18
Maximum Coil Output 19
Secondary Circuit Resistance 19
Coil And Condenser Action 19
Breaker Point Condition 19
Cylinder Timing Accuracy 19
Snap Acceleration 19
Cylinder Comparison 19
Alternator Diode Test 20
Electronic Ignition Scope Testing 21
HEI Testing Information 22

ENGINE PERFORMANCE ANALYSIS GUIDE

Area Performance Test Analysis 23
Analysis Guide 23
1. Cranking Mode 23
Coil Output 23
Test Indications 23
Starter Current 23
Test Indications 23
Battery Voltage 23
Test Indications 24
Engine Vacuum 24
Test Indications 24
2. Charging Mode 24
Charging System 24
Test Indications 24
Diode Stator 24

Test Indications 24
3. Idle Mode 24
Revolutions Per Minute RPM 24
Test Indications 24
Dwell 24
Test Indications 25
Initial Timing 25
Test Indications 25
Carbon Monoxide At Idle 25
Test Indications 25
Hydrocarbon At Idle 25
Test Indications 25
Engine Vacuum 25
Test Indications 25
Positive Crankcase Ventilation (PCV) 25
Test Indications 25
4. 1200 RPM Low Cruise Mode 25
Coil Polarity 25
Test Indications 25
Spark Plugs 26
Test Indications 26
Maximum Coil Output 26
Test Indications 26
Secondary Insulation 26
Test Indications 26
Secondary Resistance 26
Test Indications 26
Coil-Condenser 26
Test Indications 26
Breaker Points 27
Test Indications 27
Cylinder Timing 27
Test Indications 27
Carbon Monoxide At Low Cruise 27
Test Indications 27
Hydrocarbon At Low Cruise 27
Test Indications 27
5. Cylinder Power Balance Mode 27
Test Indications 27
6. Snap Acceleration Mode 27
Plugs Under Load 27
Test Indications 27
7. 2500 RPM High Cruise Mode 28
Timing Advance 28
Test Indications 28
Dwell 28
Test Indications 28
Charging Volts 28
Test Indications 28
Carbon Monoxide 28
Test Indications 28
Hydrocarbon 28
Test Indications 28
Engine Vacuum 29
Test Indications 29

METER AND GAUGE TESTING

RPM X 100 Tachometer 31
Test Connections 31
Cylinder Power Balance Test 31
Shorting In Pairs 31
Shorting In Combinations 32
Carburetor Power Balance Test 32
Idle Speed 33
Positive Crankcase Ventilation Test 33
Dwell-Amps Meter 33
Dwell Test Connections 33
Dwell Test 33
Dwell Variation
(Contact Controlled Systems Only 33
Distributor Resistance 34
Amps Test Procedure 34
Alternator Output Test 34
Volt-Ohm Meter 34
Cranking Voltage Test 34
Charging Voltage Test 34
Ignition Primary And Bypass Circuit Test 34
Ohmmeter Calibration 35
Coil Primary Resistance Test 35
Coil Secondary Resistance Test 35
Coil Primary Ground Test 35
Secondary Ignition Circuit Resistance Test 35
Alternator Rotor Circuit Resistance 35
Vacuum Gauge 35
Cranking Vacuum Test 35
PCV Valve Test 36
Idle Vacuum Test 36
Exhaust Restriction Test 36
Fuel Pump Vacuum Test 36
PPM HC And % CO Meters 36
Connection, Warm-Up And Calibration 37
Testing Procedure 37
Engine Performance Test 37
Common Causes Of Excessive Emissions 38
Carburetor Adjust And Testing 38
Idle Adjustment After Major
Carburetor Overhaul Or Repair 38
PCV Test 39
Accelerator Pump Test 39
Air Pump Test 39
Timing Advance Unit 39
Initial Timing 39
Timing Advance 40

MAINTENANCE AND SERVICE

Operating Service Instructions 41
Service Procedure 41
Maintaining Tester Finish 41
Lubrication 41
Plastic Mesh Filter Service 41
Test Lead Maintenance 41
Probe Maintenance 41
Sampling Hose Maintenance 41
Filters 41
When to Service 42
Primary Filter Service 42
Secondary Filter Service 42

SUN 1115 INFRARED GAS CALIBRATION PROCEDURE

Infrared Check Procedure Using Span Gas 45
Preliminary Mechanical/Electrical Zero
and Span Adjustment 45
Low and High Scale Comparison Check 46
Gas Calibration Procedure 46
Calibration Check Procedure 47
Low Pressure Hookup 48

SUN 1115-9 INFRARED OPERATING AND GAS CALIBRATION PROCEDURE

Preparation 49
Zero/Span Set 49
Engine Exhaust Testing 49
Preparation 49
Testing 49
Leakage Test Calibration 50
Infrared Calibration Internal Mode 50
Infrared Calibration External Mode 50
Pneumatic Diagram For Sun 1115-9 52

COMPONENTS AND ACCESSORIES 53

FIGURE 1—The Sun 1115 Performance Analyzer consisting of an analog scope section (left) and a meter and gauge section (right).

GENERAL INFORMATION

OPERATOR'S MANUAL

This manual will assist you to quickly become familiar with the SUN 1115 Tester. The GENERAL INFORMATION and AREA TESTING sections are your key to understanding your tester. The GENERAL INFORMATION section gives the location and function of each control and gauge. The AREA TESTING section shows you how to connect the tester to the vehicle and how to perform a series of important tests that are used to check out an engine. These area tests are used to:

1. Determine overall engine performance prior to service work.

2. Determine what systems are failing and need further testing.

3. Determine if any important step was overlooked during service work by quality control testing after service work is completed.

Sun's Specifications and other published materials along with the information in the remaining sections of this manual provide you with the detailed testing methods needed to thoroughly test a vehicle. Once you have become familiar with area testing, you can do detailed testing to check out any failure or malfunction detected during area testing.

TESTER INFORMATION

The Tester provides electronic testing of the various systems and components of an engine. The tester consists of two sections: the Analog Scope Section and the Meter and Gauge Section. See Figure 1.

HEAD SIGN

A fully illuminated head sign is mounted across the top of the headframe. This sign and the meters and gauges are controlled by the AC Power Switch on the left end panel. The AC Power Switch is a three position switch with Center OFF. With the switch in the left LIGHT ON position, the head sign and meters and gauges will light for tester display purposes. With the switch in the right UNIT ON position, all units in the tester are operative including sign, scope, scale reminders, meters and gauges, etc.

ANALOG OSCILLOSCOPE

The analog scope features a 20-inch screen with greater vertical display capabilities, thus increasing the readability of the raster display by allowing a greater spread of the patterns and making them easier to see (Figure 2). The scope has the facilities for displaying special waveforms for testing alternators, regulators, electronic ignition systems and other electronic systems. It provides methods for testing conventional, transistor, and capacitive discharge type ignition systems.

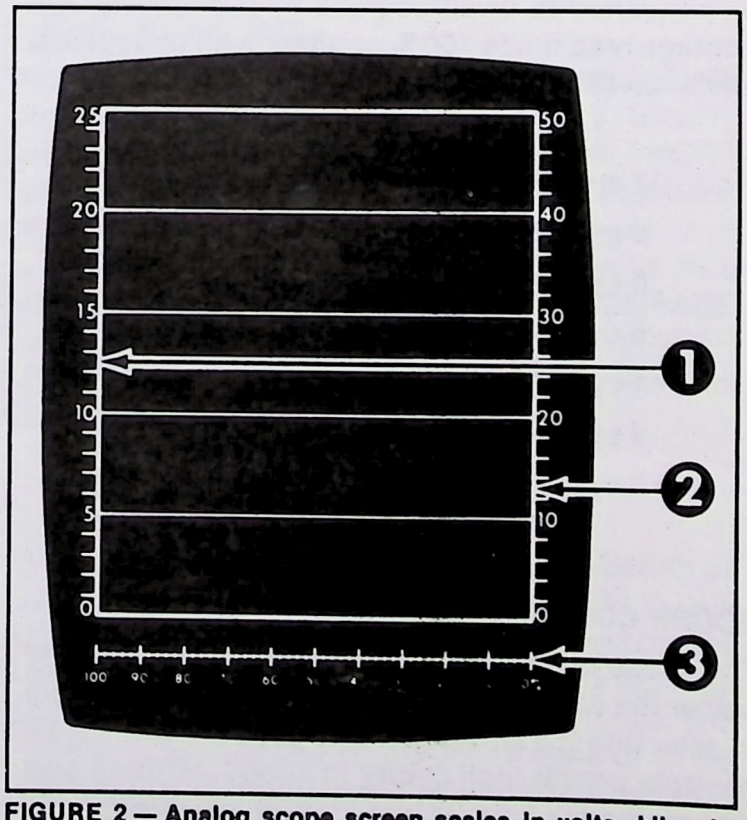


FIGURE 2 — Analog scope screen scales in volts, kilovolts and degrees.

READING DWELL ON SCOPE

The dwell angle is read as a percentage of the total duration for one cylinder's firing cycle. On an 8 cylinder engine, 100 percent of dwell is 45 degrees. The procedure for determining dwell on an 8 cylinder engine is as follows:

1. Read percentage of dwell on the scope screen.
2. Multiply 45 degrees by the percentage of dwell read.
3. The product is the degrees of dwell.

EXAMPLE #1: If you read 50% dwell, multiply 45° by 0.50:

45°
0.5
22.5° is the dwell angle.

NOTE: Percentage must be converted to a decimal fraction during calculations.

EXAMPLE #2: If you read 40% dwell, multiply 45° by 0.40:

45°
0.4
18.0° is the dwell angle.

By knowing 100% of dwell for a given engine, any percentage of dwell read on the scope screen can be converted to dwell degrees by multiplying percentage read times 100% engine dwell in degrees. 100% dwell for all test engines are:

12 cylinder engine = 30 degrees
8 cylinder engine = 45 degrees
6 cylinder engine = 60 degrees
5 cylinder engine = 72 degrees
4 cylinder engine = 90 degrees
3 cylinder engine = 120 degrees
2 cylinder engine = 180 degrees

SCOPE CONTROL PANEL

The scope controls, located on the panel directly below the scope display screen, provide a means of selecting the type of display desired. The scope controls permit high clarity in scope patterns and new methods of displaying ignition waveforms for more accurate analysis (Figure 3).

Function Selector

The FUNCTION SELECTOR (Figure 3, 1) is a four position rotary switch used to select the waveform that is to be displayed on the scope. The first position (SECONDARY) is used when secondary ignition waveforms are to be displayed. The second and third positions (PRIMARY + and PRIMARY —) are used for positive and negative primary waveforms.

The fourth position (SPECIAL PATTERNS) is used to display the special waveforms picked up at the alternator output terminal, or positive battery terminal. The SPECIAL PATTERNS position can also be used for viewing other waveforms such as fuel injection.

Pattern Height

The PATTERN HEIGHT control (Figure 3, 2) is a three position switch used to select the vertical height of the waveform displayed on the scope. When either primary or secondary ignition waveforms are being displayed and this control is set in the LOW position, the left hand 0 to 25 scale on the scope screen is used as a measuring device. When the control is set in the HIGH position, the right hand 0 to 50 scale is used. The VARIABLE position of the control activates the VARIABLE ADJUST knob which provides a means of adjusting the vertical display of any waveform being viewed.

Variable Adjust

The VARIABLE ADJUST knob (Figure 3, 3) provides the means of manually adjusting the vertical height of the pattern being displayed. This control is only operative when the PATTERN HEIGHT knob is set in the VARIABLE position.

Pattern Selector

The PATTERN SELECTOR (Figure 3, 4) is another three position rotary switch which provides a means of selecting "how" an ignition waveform is to appear on the scope screen. In the DISPLAY position, all of the ignition waveforms appear in a horizontal chain across the screen. The #1 cylinder pattern is at the left (except for its firing line) and the other cylinder patterns follow to the right in the engine's firing order.

In the RASTER position, all cylinder patterns are viewed at full screen width. The pattern of #1 is at the bottom, and the other cylinder patterns are evenly spaced above, again in the engine's firing order.

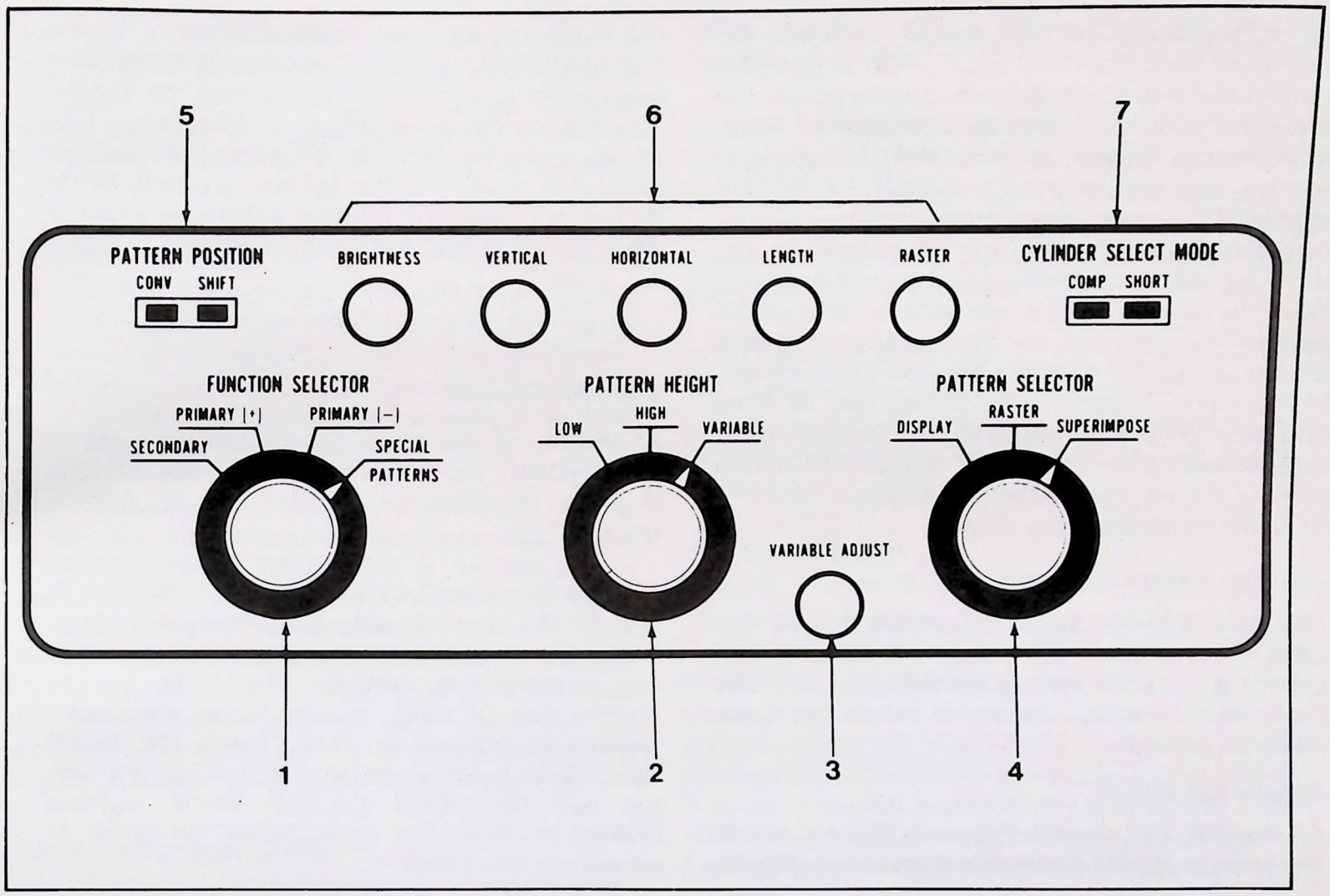


FIGURE 3 — Analog scope panel of controls.

In the SUPERIMPOSE position, all cylinder patterns are placed one behind the other on the zero line of the scope screen.

Pattern Position

The PATTERN POSITION control (Figure 3, 5) consists of two buttons (CONV and SHIFT). In RASTER and SUPERIMPOSE when the CONVENTIONAL (CONV) button is depressed, the ignition patterns displayed will begin with the spark line on the left end of the pattern and the firing line at the right end of the pattern. Depressing the SHIFT button will result in a pattern shift to the right, causing the waveforms displayed to begin with the firing line at the left. In DISPLAY when the SHIFT button is depressed, the firing line of the #1 cylinder which normally appears at the far right is shifted to the far left.

Five Pattern Adjustment Controls

Directly to the right of the PATTERN POSITION buttons are five pattern adjustment controls (Figure 3, 6), which provide adjustment of the scope's BRIGHTNESS, the VERTICAL position of the waveform displayed, the HORIZONTAL position of the waveform, the LENGTH of the waveform, and the spacing between waveforms when they are displayed in the RASTER mode.

Cylinder Select Mode

The CYLINDER SELECT MODE (Figure 3, 7) allows the selection of two buttons, a SHORT button and a COMPARE button. With the SHORT button depressed, the 8 buttons on the CYLINDER SELECTOR on the center panel of tester are used to short out the engine cylinders required to do a cylinder power balance test. With the COMPARE button depressed, the 8 buttons on the CYLINDER SELECTOR are used to select display patterns on the scope.

By depressing the SHORT button and selecting an individual or a group of buttons on the CYLINDER SELECTOR, the ignition for the corresponding engine cylinders is electronically shorted out. Shorting cylinders individually or in groups provides an accurate and convenient means of determining the comparative overall operating efficiency of each engine cylinder.

Depressing the COMPARE button switches the function of the CYLINDER SELECTOR to permit it to alter the waveform pattern displayed on the scope. For example, with ignition system waveforms being viewed in the DISPLAY manner, pushing any one of the CYLINDER SELECTOR buttons will cause the corresponding cylinder waveform to be removed from the normal display and to appear in an enlarged form, centered and above the others on the scope screen. This feature permits the operator to enlarge any cylinder's pattern as desired for more detailed examination. The COMPARE button also allows two or more cylinders to be superimposed for close comparison. Releasing the CYLINDER SELECTOR button permits the enlarged waveform to again return to its usual position in the display.

CENTER PANEL CONTROLS

The tester's center panel of controls (Figure 4) is used to select the type of engine and number of cylinders to match the vehicle being tested. This panel also contains controls to select additional tester functions.

Engine Kill Button

An ENGINE KILL button (Figure 4, 1) is located on the panel to provide a convenient means of stopping the engine if an unexpected emergency arises. The ENGINE KILL control shorts out the ignition system for all cylinders and disables the engine. Besides being an emergency feature, it also allows cranking tests to be performed without physically disabling the ignition system. When button is Green, the ignition system is enabled. When button is Red, the ignition system is disabled.

Cylinder Selector

At the top of the panel, directly to the right of the ENGINE KILL button, is a series of nine buttons, identified as a CYLINDER SELECTOR (Figure 4, 2).

The buttons identified by numbers 1 through 8, are of the push-to-set, push-to-release type. These can be set and released individually, or in any combination desired. The ninth button, identified as CANCEL, is used to simultaneously release all buttons at once. These CYLINDER SELECTOR buttons are used in conjunction with the two CYLINDER SELECT MODE buttons located in the control panel below the scope as previously described.

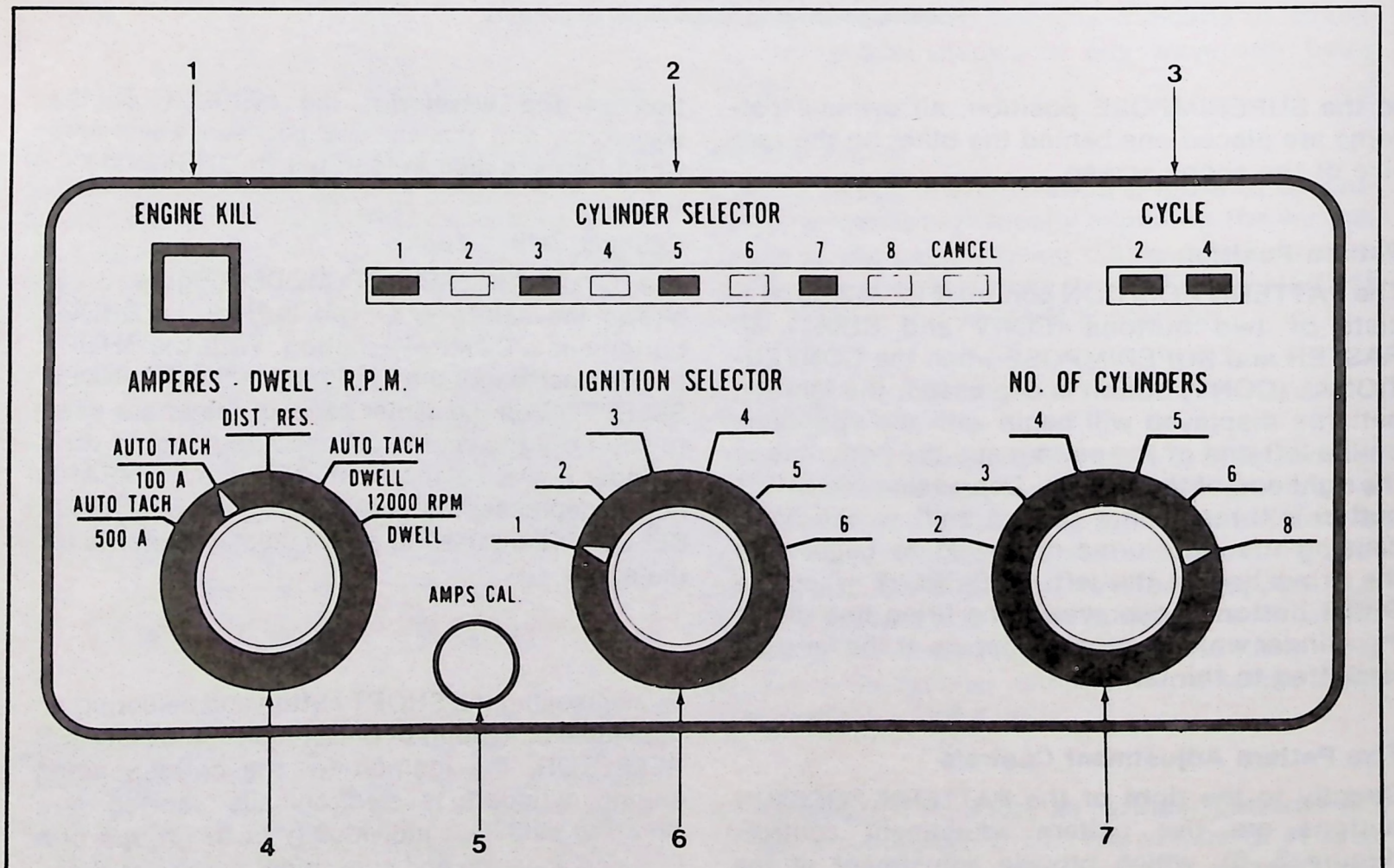


FIGURE 4— The center panel of controls.

Cycle Selector Buttons

The CYCLE control selector buttons (Figure 4, 3) are used to select the type of ignition system being tested. It is a two button control used to program the tester for 4 cycle or 2 cycle/rotary type ignition systems.

Amperes-Dwell-RPM Control

The AMPERES-DWELL-RPM controls (Figure 4, 4) is a rotary knob used to select testing of amps, engine speed, dwell, or point resistance. The control knob has five positions which are used to select the type of readings being indicated on the AMPS-DWELL meter.

The two bottom scales on the DWELL-AMPS meter are for measuring amperes when the AMPERES-DWELL-RPM knob is in either the AUTO-TACH/100A or AUTO-TACH/500A position. The scale at the top of the meter has a DIST RES (distributor resistance) section and a Dwell Section calibrated in degrees. This scale is operative when the AMPERE-DWELL-RPM knob is set at DIST RES or either the AUTO-TACH/DWELL position or the 12000 RPM/DWELL position.

Amps Calibration Control

The AMPS CAL knob (Figure 4, 5) is used to calibrate the ampere meter scale electrically. With the AMPERE-DWELL-RPM knob in the AUTO-TACH/100A position, the AMPS CAL knob is used to set the AMPS-DWELL meter pointer to zero. This is done before the tester leads are hooked to the vehicle.

Ignition Selector Control

The IGNITION SELECTOR (Figure 4, 6) is used to select the testing circuit of the tester that matches the type of ignition used on the test vehicle. This control is a six position knob, having positions numbered 1 through 6. Position #1 is for all U.S. production systems, except General Motors HEI and Prestolite BID ignition systems. Prestolite is used as original equipment on American Motors, Jeep, and International Harvester, and is sold as an aftermarket system for many vehicles. Position #2 is used on any ignition that has voltage increases or humps occurring during the dwell portion of the waveform, such as the Delco-Remy HEI and Prestolite BID Ignition systems.

Position #3 provides a capability opposite to Position #1 in that the primary signal takes precedence over the secondary, providing a possible use on systems that will not trigger properly in positions #1 or #2. Position #4 provides a low level primary for use on Capacitive Discharge (CD) systems. Positions #5 and #6 are wired the same as Position #2 at this time.

Number Of Cylinders Control

The NO. of CYLINDERS knob (Figure 4, 7) is a six position rotary switch used to select the testing circuit of the tester that matches the number of cylinders used in the test vehicle. The knob positions stand for the number of engine cylinders.

RIGHT PANEL CONTROLS

The tester's right panel of controls (Figure 5) is used to select the volts and ohm ranges to be used as well as the controls for testing hydrocarbons and carbon monoxide.

Volt-Ohm Control

The VOLT-OHM knob (Figure 5, 1) is used to select three voltage scales and three ohm scales. The scales controlled by this VOLT-OHM knob are those on the VOLT-OHM meter on the tester. The top two scales on the meter are for measuring voltage. When the VOLT-OHM knob is set to the 20V position, the 0 to 20 volt scale is used. When it is set to the 40V position, the 0 to 40 volt scale is used; and when it is set to the 4V position, the 0-40 volt scale is used but is interpreted as a 0 to 4 volt scale.

The bottom scale on the VOLT-OHM meter is for measuring ohms. When the VOLT-OHM knob is set to the OHM position, the bottom scale is read as marked on the meter (0-100 ohms). When the knob is set to the OHM x 100 position, the scale is read on the meter and multiplied by 100 to obtain the correct value; and when the knob is set to the OHM x 1000 position, the scale is read on the meter and then multiplied by 1000.

Ohms Cal Control

The OHMS Cal knob (Figure 5, 2) is used to zero the ohms scale on the VOLT-OHM meter when the VOLT-OHM meter is set to the OHM position. The two ohm leads of the tester are clamped together and the OHMS CAL knob adjusted until the pointer is zeroed on the ohm scale. When the VOLT-OHM knob is set to either the OHM x 100 or the OHM x 1000 positions, the tester automatically sets the pointer to zero; that is, these two positions are self-calibrating.

Hydrocarbon Zero And Span

The HYDROCARBON ZERO and SPAN knobs (Figure 5, 3) provide adjustments for the zero and full-scale deflections of the PPM HC meter pointer. These adjustments are needed to insure

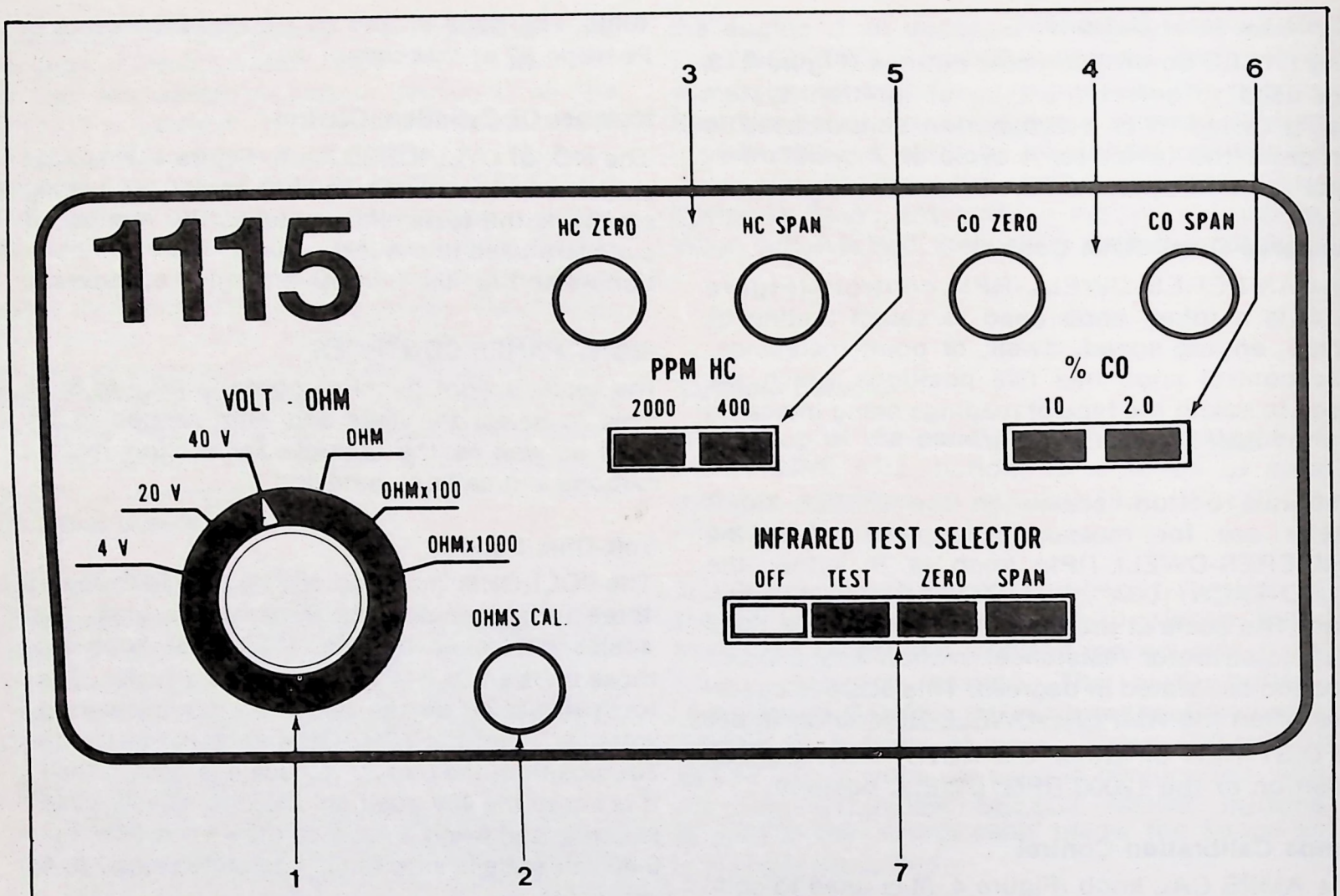


FIGURE 5 — Right panel controls.

the accuracy of the hydrocarbon meter for the auto being tested.

Carbon Monoxide Zero And Span

The CARBON MONOXIDE ZERO and SPAN knobs (Figure 5, 4) on the control panel provide a means of adjusting the zero and full-scale deflections of the % CO meter pointer. These adjustment knobs insure accurate carbon monoxide readings of the meter.

Hydrocarbon High And Low

The HYDROCARBON HIGH and LOW buttons (Figure 5, 5) allow the operator to select either the high or low range scale of the PPM HC meter.

Carbon Monoxide High And Low

The CARBON MONOXIDE HIGH and LOW buttons (Figure 5, 6) allow selection of either the high or low % CO meter range by the operator.

Infrared Test Selector

The INFRARED TEST SELECTOR buttons (Figure 5, 7) are the master control for the hydrocarbon and carbon monoxide exhaust emission meters. They are TEST, ZERO and SPAN. When the ZERO button is depressed, both PPM HC and % CO meter pointers can be zeroed. When the SPAN button is pushed, the pointers can be adjusted for full scale deflection using the SPAN control knobs. In TEST, the HC and CO meters are ready for use.

METERS AND INDICATOR LIGHTS

Directly below the R.P.M. x 100 Meter, the AMPS-DWELL Meter, the VOLT-OHM Meter, PPM HC Meter and the % CO Meter are scale indicator lights which remind the operator of the scale ranges that are to be read. There is a scale reminder light for each scale of each meter and each indicator light is the same color as the meter scale it indicates. See Figures 6 through 10.

The VACUUM gauge dial does not have indicator lights (Figure 11). Either of the two scales can be read whenever vacuum is being tested. One is in inches and the other is in millimeters.

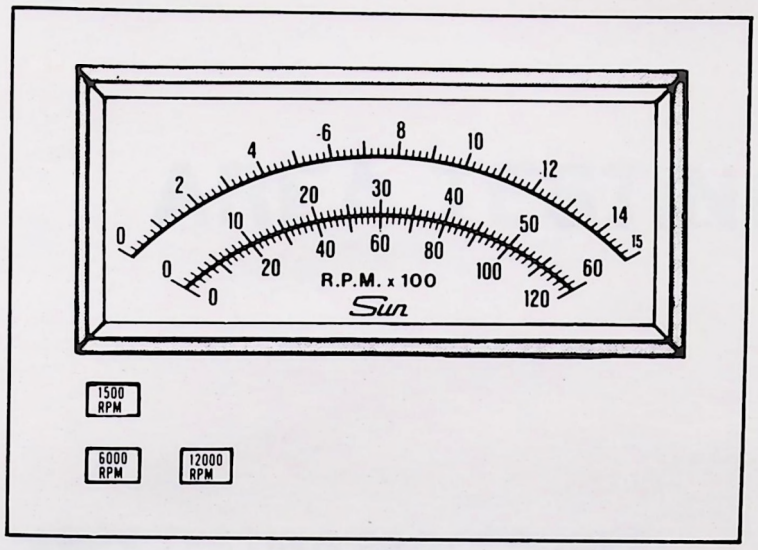


FIGURE 6 — RPM x 100 meter and indicator lights.

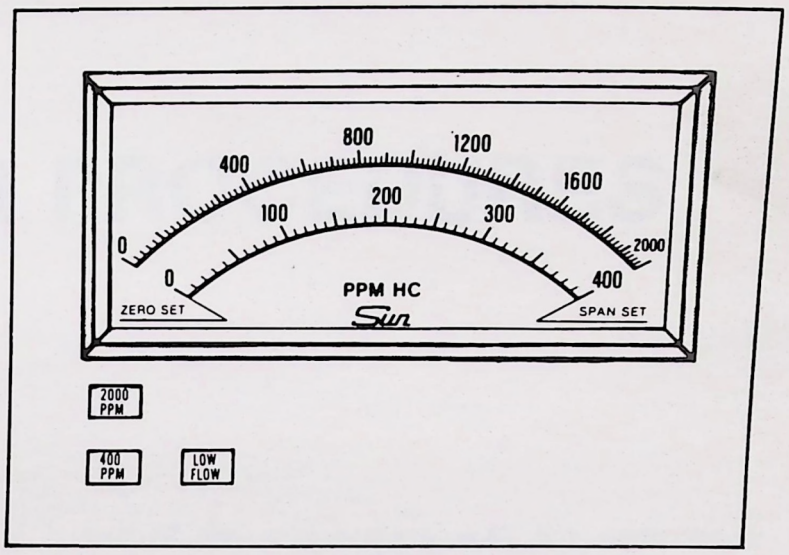


FIGURE 9 — PPM HC meter and indicator lights.

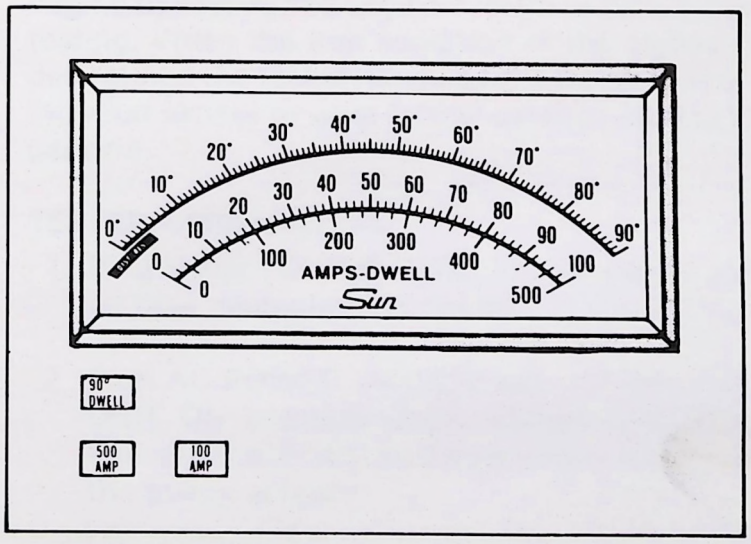


FIGURE 7 — AMPS-DWELL meter and indicator lights.

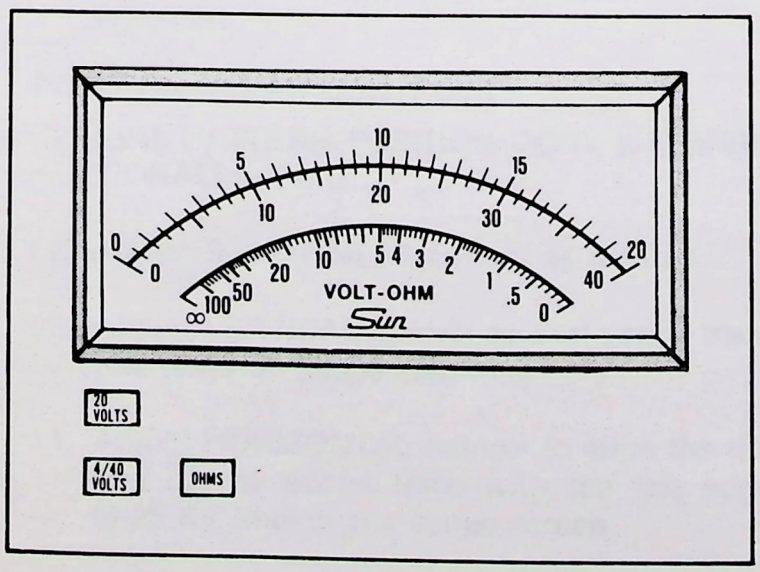


FIGURE 8 — VOLT-OHM meter and indicator lights.

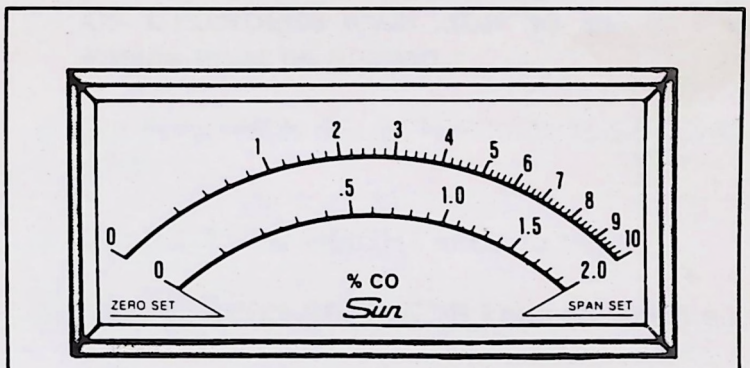


FIGURE 10 — Percent CO meter and indicator lights.

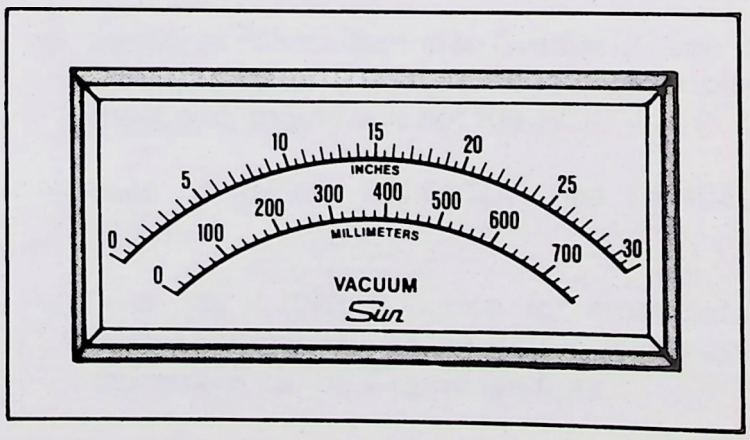


FIGURE 11 — VACUUM gauge meter.

Low Flow Indication

The LOW FLOW indicator below the PPM HC Meter (Figure 9) is illuminated in Yellow when the exhaust gas sampling system becomes restricted because of clogged filters, kinked pickup hose, etc. The LOW FLOW light is a warning that the Infrared system needs maintenance.

AREA TESTING PROCEDURES

AREA TESTING PROCEDURES

The factual information obtained from a systematized series of tests, when compared with specifications and known standards, provides an accurate picture of an engine's conditions. This series of tests to determine the true condition of the engine by testing the engine system is called area testing. When the true condition of the engine is determined the technician has little trouble knowing what service or what further detailed testing to perform.

TESTER PREPARATION

1. Plug tester POWER CORD into proper ac outlet (see nameplate on tester).

2. Turn AC POWER SWITCH (left end panel) to UNIT ON position. Sign, Meters and Scale Indicators will light and a trace will appear on the scope screen.

3. Place GAS CALIBRATE switch at rear of tester in OPERATE position.

4. Depress ZERO mode control button of INFRARED TEST SELECTOR to allow exhaust analyzer to warm while tester is being prepared.

POSITION SCOPE CONTROLS

1. Push PATTERN POSITION CONV (CONVENTIONAL) button.

2. Adjust BRIGHTNESS control as desired.

3. Adjust VERTICAL control so that scope trace line rests on scope zero line.

4. Adjust HORIZONTAL control to align the left end of the scope trace with the left edge (0-25 KV line) of the scope screen.

5. Adjust the LENGTH control to align the right end of the scope trace with the right edge (0-50 KV line) of the scope screen.

   NOTE: To adjust LENGTH control, the NO. OF CYLINDERS knob must be set to 8 or engine must be running.

6. Set FUNCTION SELECTOR knob to SECONDARY.

7. Set PATTERN HEIGHT knob to HIGH.

8. Set PATTERN SELECTOR knob to DISPLAY.

   NOTE: The RASTER control is not adjusted at this time. Adjust RASTER when necessary during testing.

POSITION TESTER CONTROLS

1. Push CYLINDER SELECT MODE SHORT button.

2. Set ENGINE KILL button to GREEN. (Green is the Run position. Red means ignition is disabled and engine will not run.)

3. Push CYLINDER SELECTOR Red CANCEL button.

4. Push the 4 CYCLE button for most automotive engines except the Rotary engine and any others having 2 cycle ignition.

5. Set the AMPERES-DWELL-RPM knob to AUTO-TACH/100A position and zero ammeter with the AMPS CAL knob. Then set AMPERES-DWELL-RPM knob to AUTO-TACH/500A position.

6. Set the IGNITION SELECTOR knob to #1 position except as follows:

   a. Delco HEI and Prestolite BID systems, set to #2 position.

b. Capacitive Discharge (CD) systems, set to #4 position.

7. Set NO. OF CYLINDERS knob to match the number of cylinders in engine being tested.

8. Set VOLT-OHM knob to 20V position.

CALIBRATE HC AND CO METERS

1. Allow depressed zero mode control button to remain depressed for 5 minutes to warm up tester.

2. Depress PPM HC 400 and % CO 2.0 buttons.

3. Adjust Zero knobs below meters until both meter pointers read ZERO SET.

4. Depress and hold SPAN mode control button while adjusting SPAN knobs below meters until both meter pointers read SPAN SET

5. Release SPAN button and recheck ZERO adjustment.

6. Push TEST button on INFRARED TEST SELECTOR.

NOTE: During first 15 minutes of operation, tester may require slight additional calibration adjustments. Calibration can be checked at any time by repeating steps above. It is not necessary to remove sample probe from tail pipe or to stop vehicle engine to recheck calibration of tester.

LEAD CONNECTIONS TO VEHICLE

(Negative ground systems shown) See Figure 12.

1. Clamp Chrome PATTERN PICKUP around the secondary coil wire. (On G.M. HEI Systems, with ignition coil in distributor cap, use Sun HEI Adapter #1747-102.)

   a. Connect Red PRIMARY PICKUP to the negative terminal of the ignition coil (on electronic and transistor ignition, to the specified terminal).

   b. Connect Black (Ground) PRIMARY PICKUP to a **good** engine ground.

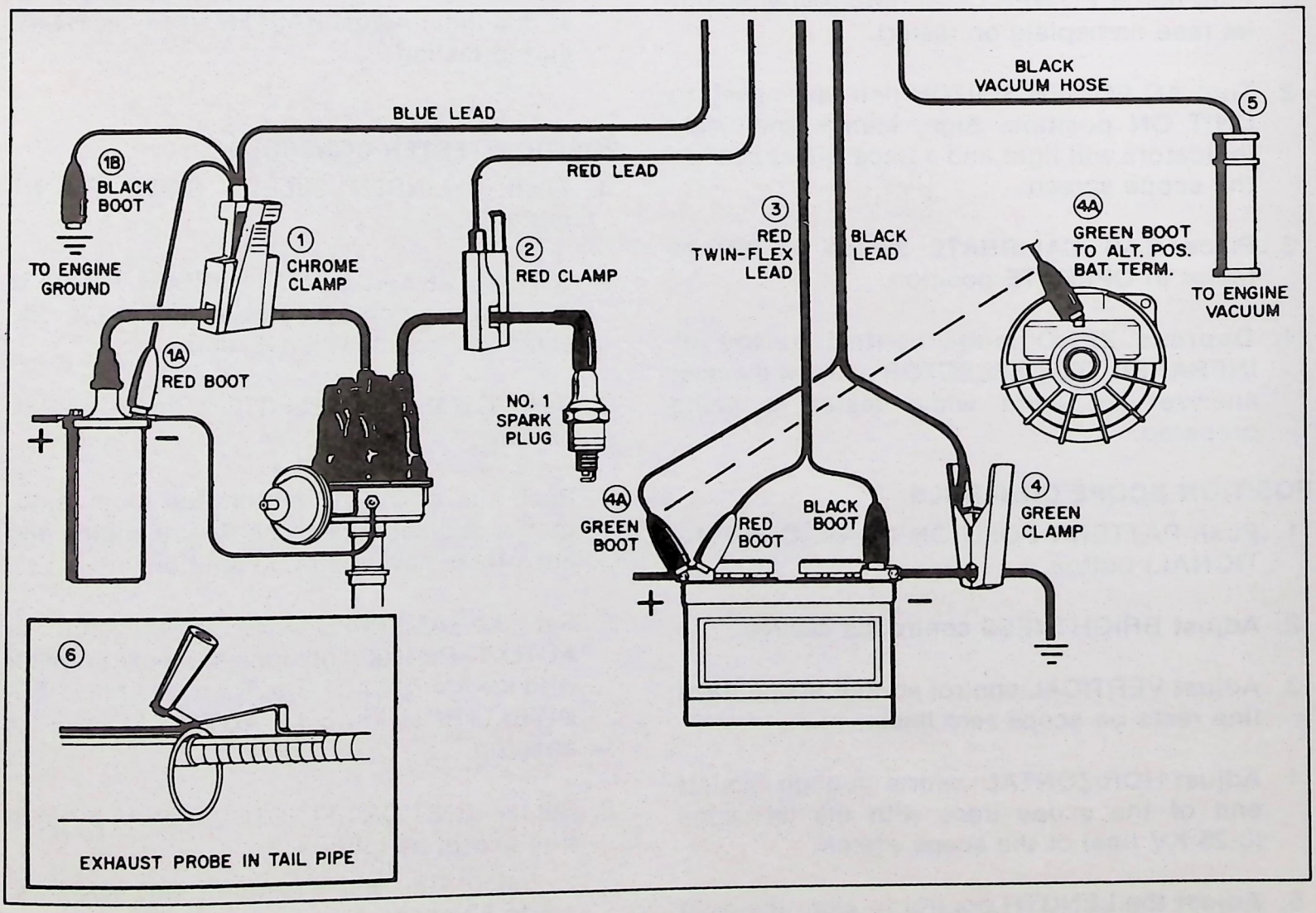


FIGURE 12 — Test lead connections to engine.

2. Clamp Red TRIGGER PICKUP around number 1 spark plug wire close to the distributor cap.

3. Connect VOLT-OHM leads to battery posts, Red to positive and Black to negative.

4. Clamp Green AMMETER PICKUP around negative battery cable (all negative cables if there are more than one) with arrow pointing away from the battery.

   a. Connect Green SPECIAL PATTERNS PICKUP to the positive (+) battery post.

   NOTE: If accessible, the alternator output (+) terminal can be used.

5. Connect VACUUM HOSE to a source of engine vacuum.

6. Insert EMISSION SAMPLING PROBE into vehicle tail pipe.

TESTING PROCEDURE

For best results use the SUN 1115 Engine Performance Test Report. Enter specifications, perform specified tests and enter test results for evaluation when finished with each test.

Test 1 — Cranking Tests

1. Disable the ignition system by disconnecting secondary coil wire from distributor cap; position end clear of ground. (To disable all HEI ignition systems, push ENGINE KILL button so it shows Red.) Turn off all lights and accessories.

2. Crank engine while reading the indications on the tester instruments.

   a. Note Cranking Coil Output in kilovolts on 50 KV scale of scope.

   NOTE: This test void when using ENGINE KILL BUTTON.

   b. Read Cranking Starter Current on Blue 500 amp scale of ammeter.

   c. Read Cranking Battery Voltage on Red 20 volt scale of voltmeter.

   d. Read Cranking Engine Vacuum on vacuum gauge.

Test 2 — Charging Tests

1. Turn AMPERES-DWELL-RPM knob to AUTO-TACH/100A scale.

2. Set FUNCTION SELECTOR knob to SPECIAL PATTERNS.

3. Set PATTERN HEIGHT knob to VARIABLE, and set VARIABLE ADJUST to full clockwise.

4. Set PATTERN SELECTOR knob to RASTER.

5. Prepare engine to run. Enable ignition system or release ENGINE KILL button to Green.

6. Start engine, accelerate to 2000 rpm.

   a. Note alternator output on Blue 100 amp scale of ammeter.

   b. Note condition of diodes/stator as indicated by scope patterns.

   (Use RASTER control if necessary to space scope patterns for best viewing.)

7. Return engine to idle speed.

Test 3 — Idle Tests

1. Turn AMPERES-DWELL-RPM knob to AUTO-TACH/DWELL.

2. Set FUNCTION SELECTOR knob to SECONDARY.

3. Set PATTERN HEIGHT knob to HIGH.

4. Set PATTERN SELECTOR knob to DISPLAY.

5. Warm up engine until choke is open and engine is at normal idle speed.

   a. Read idle rpm on Red 0-1500 rpm scale of tachometer.

   b. Read dwell on Red dwell meter scale.

   c. Check initial timing with timing light as specified for engine being tested.

   d. Read carbon monoxide percentage on CO meter.

   e. Read hydrocarbons ppm on HC meter.

   f. Read engine manifold vacuum on vacuum gauge.

g. Test PCV valve per manufacturer's recommended procedure.

Test 4 — 1200 RPM Low Cruise

NOTE: Refer to the Analog Scope Testing section for examples of the various scope patterns.

1. Run engine at approximately 1200 rpm and perform scope tests.

   a. Coil polarity in DISPLAY.

   b. Spark plug firing voltage (KV) in DISPLAY.

   c. Maximum coil output (available voltage) in DISPLAY.

   d. Secondary insulation in DISPLAY.

   e. Secondary resistance in RASTER.

   f. Coil and condenser condition in RASTER.

   g. Breaker point condition in RASTER.

   NOTE: Static point resistance test can also be made to check breaker point condition.

   h. Cylinder timing accuracy in SUPERIMPOSE.

   i. Read carbon monoxide percentage on CO meter.

   j. Read hydrocarbons ppm on HC meter.

   k. Push ZERO button on INFRARED TEST SELECTOR.

Test 5 — Cylinder Power Balance

1. Set PATTERN SELECTOR knob to DISPLAY.
2. Run engine at desired test speed — record base rpm.
3. Press CYLINDER SELECTOR button one at a time until all cylinders have been shorted and released one at a time.
4. Note and record rpm produced with each cylinder shorted.

Test 6 — Snap Acceleration

1. Push TEST button on INFRARED TEST SELECTOR.
2. Quickly snap accelerate engine and release throttle while observing spark plug firing lines on scope.
3. Note cylinders having firing lines too high or too low.
4. Snap accelerate the engine again and return to idle speed. Wait a few moments for CO reading to peak on the meter. Record maximum % CO.

Test 7 — 2500 RPM High Cruise

1. Set engine speed to approximately 2500 rpm.
2. Check timing advance with timing light following manufacturer's recommended procedure.
3. Read dwell in degrees on dwell meter.
4. Read charging volts on 20V scale of voltmeter.
5. Read carbon monoxide percentage on CO meter.
6. Read hydrocarbons ppm on HC meter.
7. Read engine manifold vacuum on vacuum gauge.
8. Stop engine.
9. Push ZERO button on INFRARED TEST SELECTOR.

Analyze tests results, compare with specifications and perform pinpoint tests or make service recommendations as required.

ANALOG SCOPE TESTING

ANALOG SCOPE IGNITION TESTING

The basic function of the Sun Analog Scope is to provide an instantaneous display of voltage waveforms which are necessary for analyzing ignition system and other electrical system operations. To fully utilize the test facilities provided by the analog scope, the operator should practice its applications whenever possible.

INITIAL SETUP

During the initial setup of the tester, the analog scope may require some minor adjustments before the scope is used for ignition system testing.

To perform these preliminary adjustments, turn the 1115 ON. After a few moments, a horizontal line will appear on the scope screen. The position of this line is controlled by means of knobs located on the panel. Use the VERTICAL, HORIZONTAL and LENGTH controls to position the scope trace directly on the scope Zero line with the beginning of the trace at the left end of the scale and the end of the trace at the right end of the scale.

The BRIGHTNESS control is adjusted to suit the desire of the operator. The RASTER control may be adjusted at a later time to control the vertical spacing between waveforms when ignition patterns are displayed in a raster manner.

If the VERTICAL, HORIZONTAL or BRIGHTNESS controls are adjusted to the extreme end of their range, the scope trace may be completely off of the face of the scope tube and not be visible to the operator. If the scope trace is not visible after the tester has been on for a few seconds, simply rotate the BRIGHTNESS, VERTICAL and HORIZONTAL controls until it appears somewhere on the screen.

STANDARD IGNITON TESTING

A standard ignition system is defined as a system that uses contact points and a condenser to switch primary circuit current on and off in an ignition system. An electronic ignition system is defined as any original manufacturer's equipment that makes use of an electronic circuit to switch the primary circuit current on and off instead of conventional contact points and a condenser.

NOTE: In this section, standard ignition system testing will be covered. Electronic ignition testing will be covered in a following section.

The following test information will outline some of the scope's most frequently used applications. to standard ignition systems and suggest how the scope operating controls should be positioned for each basic test.

TEST LEAD CONNECTIONS

For proper functioning, the PATTERN and TRIGGER PICKUP leads should be connected to the engine in the same manner as for performing a complete series of area tests. The Red TRIGGER PICKUP should be clamped around the number one spark plug lead, as close as possible to the distributor cap. The PATTERN PICKUP is clamped around the coil to distributor secondary lead. Connect the Red clip to the distributor terminal of the ignition coil and the Black clip to a good engine ground.

INTERPRETING SCOPE PATTERNS

The analog scope provides a convenient means of observing ignition system operation while the engine is running. It displays a graphic waveform trace pattern that is easy to interpret because each part of the waveform represents a specific phase of ignition system operation.

The waveform has three sections, representing three phases of operation. The three sections are the firing section, the intermediate section, and the dwell section. The three sections of the secondary circuit will now be discussed.

The Firing Section

During this section of the secondary circuit, waveform firing of the spark plug takes place. This section of the pattern is composed of two lines:

1. The Firing Line - a vertical line indicating the voltage required to overcome the plug and rotor gaps.

2. The Spark Line - a horizontal line indicating the voltage required to maintain the spark.

Figure 13, Portion A to B is the firing line. The *firing* indicates the voltage required to initially fire or arc the spark plug. The firing line is affected by the spark plug, plug wire, distributor rotor gap, coil wire, fuel mixture and compression. For example, if the spark plug electrode gap or the rotor gap is too wide, greater voltage is required to fire the plug. A very lean fuel mixture will also be harder to fire.

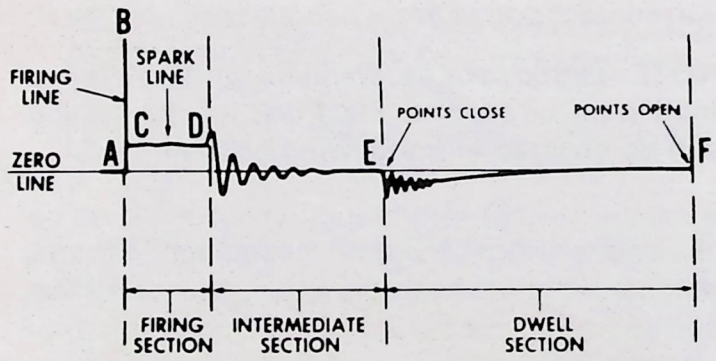


FIGURE13–The three sections of a single cylinder waveform during secondary circuit testing.

Figure 13, Portion C to D is the *spark line.* The spark line is the voltage required to continue the arcing after the spark plug's initial firing. The firing line and the spark line together make up the firing section of the pattern. This firing section is affected by the condition of the spark plug, plug wires, and the coil wire.

The Intermediate Section

This section is seen as a series of gradually diminishing oscillations which disappear or nearly disappear by the time the dwell section begins. Figure 13, Portion D to E is the intermediate section (sometimes called the *coil and condenser* section). The intermediate section is the period of time after the spark plug ceases arcing, and the remaining coil energy dissipates itself as oscillating current. The current oscillates back and forth between coil and condenser until dissipated.

The Dwell Section

The dwell section extends from breaker point closing to breaker point opening. Closing the points causes a short downward line followed by a series of small rapidly diminishing oscillations. These oscillations represent the buildup of the magnetic field around the coil that occurs when the breaker points are closed.

Figure 13, E is when the ignition points close to start a new dwell period. This area of the pattern is affected by the ignition points and coil. Figure 13, F is when the *points open* to end the dwell period. This area is affected by the ignition points, condenser, and the distributor. For example, if the distributor shaft is wobbling, the dwell time will be erratic.

Figure 13, Portion E to F is the *dwell period*. This section is affected by the point setting. The dwell period is figured in degrees.

Primary Circuit Interpretation

Since any voltage variation in the primary ignition circuit will be reflected in secondary circuit testing, it is not always necessary to use primary circuit testing to determine the general condition of the ignition system. Testing of the primary circuit is usually done to pinpoint troubles found during secondary testing.

The trace patterns of the primary circuit are very similar to that of the secondary (Figure 14). It also divides into the three sections: firing section, intermediate section, and dwell section. Although the primary and secondary patterns are similar, the voltage values represented in the primary patterns are much lower than those represented in the secondary patterns.

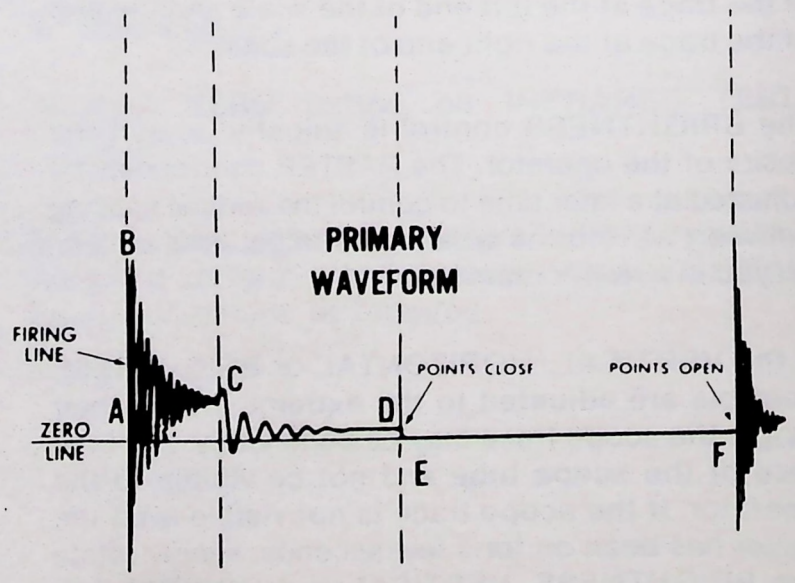


FIGURE14–The three sections of a single cylinder waveform during primary circuit testing.

Primary Firing Section

This section displays the series of rapid oscillations that take place in the ignition primary circuit during the period of time in which the spark plug fires. Figure 14, point A represents the instant at which the breaker points separate.

The vertical rise from "A" to "B" and the diminishing oscillations which follow, represent the initial and repeated charging and discharging of the condenser and the induced voltage surges in the primary circuit while the spark plug is firing. As the spark bridges the gap and energy is being drained from the coil, the amplitude of these oscillations will diminish until the spark is extinguished as indicated at point "C."

Primary Intermediate Section

As in the secondary pattern, the Intermediate Section is seen as a series of gradually diminishing oscillations which disappear or nearly disappear by the time the Dwell Section begins. Beginning at point "C," what energy still remains in the coil will dissipate itself as an oscillating current which gradually dies out as it approaches point "D."

Primary Dwell Section

The Intermediate Section ends and the Dwell Section begins simultaneously when the distributor contacts close, and can be observed as a faint downward line from point "D" to point "E." The Dwell Section is represented by the horizontal line which extends from point "E" to the point "F," and it is during this period that the points remain closed.

PROGRAMMING SCOPE CONTROLS

The scope controls are located on the scope panel. Refer to Figure 3, Page 3. The scope is capable of displaying primary and secondary circuit ignition patterns in the following ways:

1. Display Pattern
2. Display Pattern in Shift
3. Display Pattern in Shift and Compare
4. Display Pattern in Compare
5. Raster Pattern
6. Raster Pattern in Shift
7. Superimposed Pattern
8. Single Cylinder Pattern
9. Special Patterns such as alternator waveform analysis

Display Pattern

With the PATTERN POSITION CONV button depressed, the PATTERN SELECTOR knob set at DISPLAY, the PATTERN HEIGHT knob at HIGH, and the FUNCTION SELECTOR knob at SECONDARY, the scope will present a parade of all cylinders as shown in Figure 15. With the TRIGGER PICKUP clamped around the number one spark plug wire, the waveform viewed on the scope screen will begin on the left with the pattern for number one cylinder. However, it should be noted that the *firing line* of number one cylinder is displayed at the extreme right at the end of the trace. The trace moves from left to right displaying the ignition cycles of each cylinder consecutively in the engines *firing order* until all cylinders are displayed on the screen.

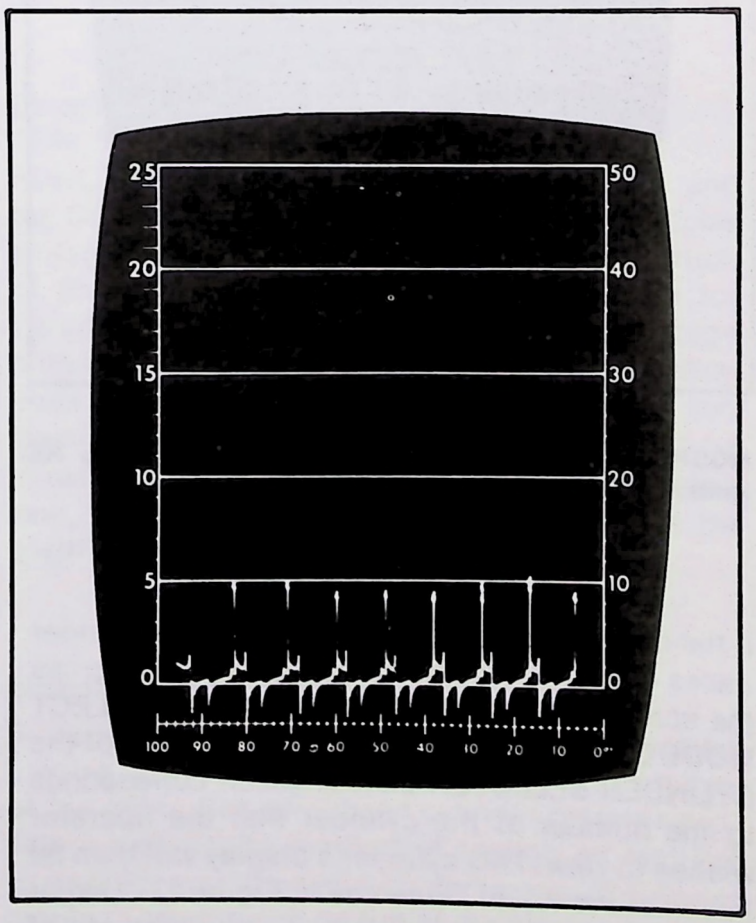


FIGURE 15— Display pattern of normal engine using HEI ignition.

Analog Scope Testing

The display type of pattern allows firing voltages to be measured. When measuring secondary voltages during maximum coil output or spark plug firing voltages, for example, the display type of pattern provides best results. For accurate voltage measurements, the base of the pattern's *firing line* must be adjusted to the zero line on the scope screen graticule.

If the operator wishes to move the number one cylinder's firing line from the extreme right to the left of the screen, all he need do is push the PATTERN POSITION SHIFT button. Now the display pattern has the firing line of the number one cylinder at the extreme left as shown in Figure 16.

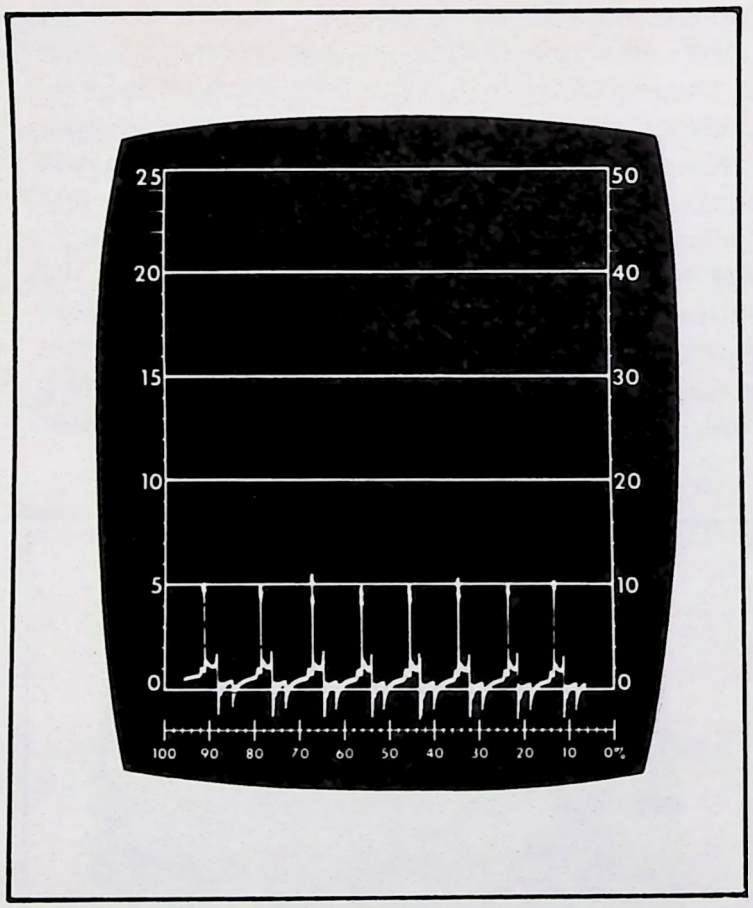


FIGURE 16 – Display pattern of normal engine using HEI ignition with shift button depressed.

If the operator wishes to move one of the cylinder traces from the parade display and extend it across the screen, he may push the CYLINDER SELECT MODE COMP button and the button number of the CYLINDER SELECTOR control which corresponds to the number of the cylinder that the operator wishes to view. This cylinder's display will then be traced at the top of screen as in Figure 17. Two or more cylinders can be superimposed at the top of the screen for close comparison by pressing more than one CYLINDER SELECTOR button.

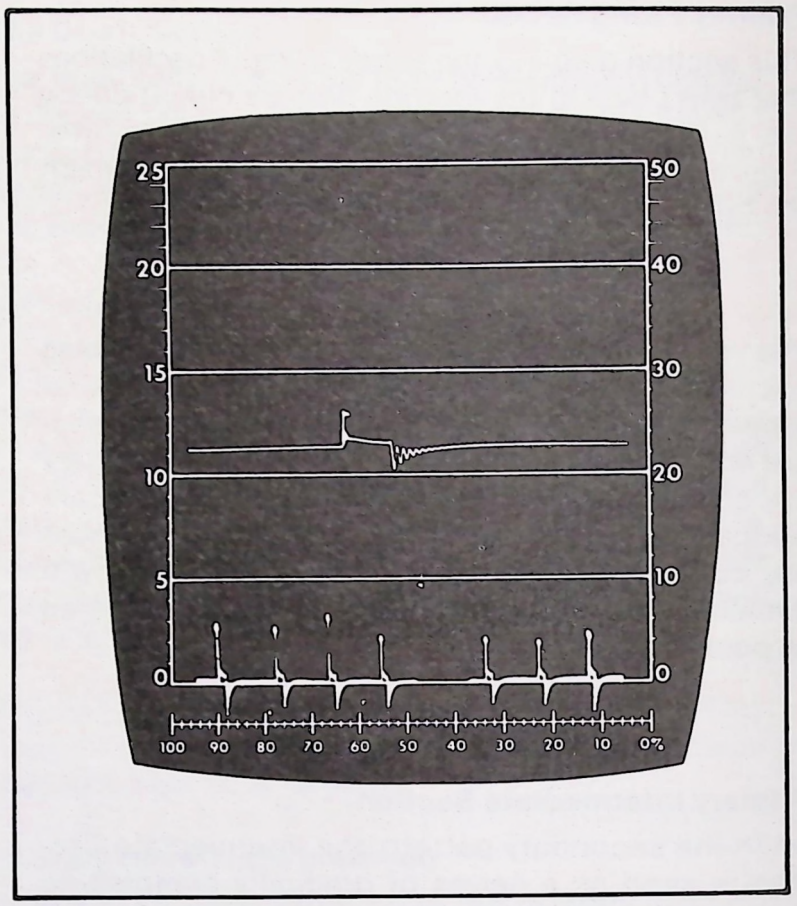


FIGURE 17 – A display pattern with the shift button, the compare button, and the number five cylinder button of the cylinder selection control depressed.

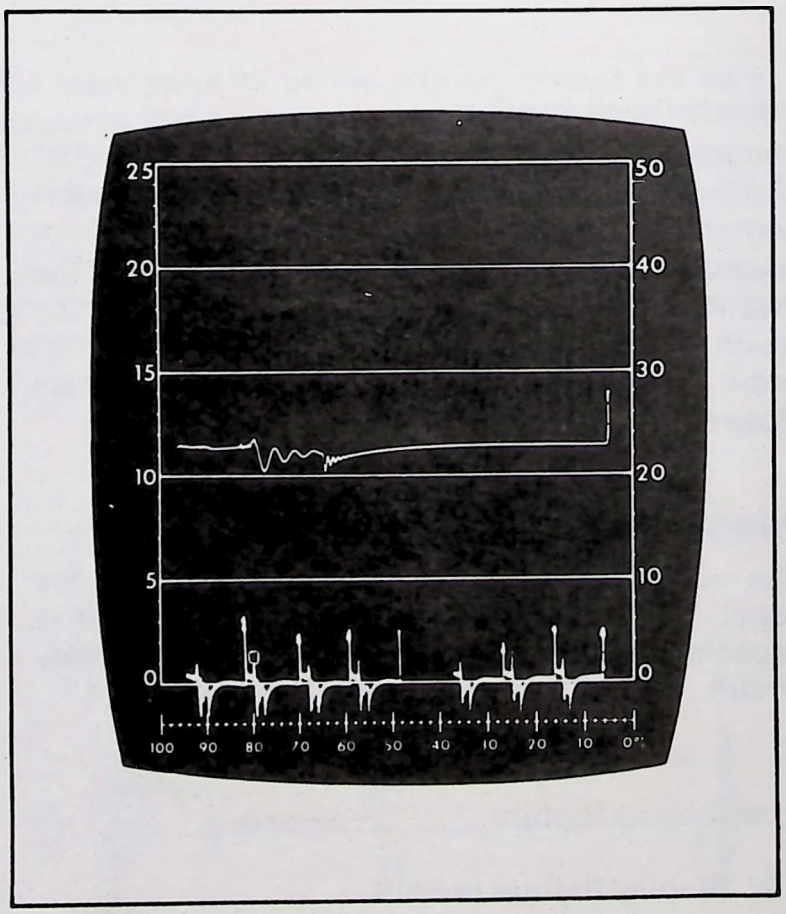


FIGURE 18– A display pattern with the conventional button, the compare button, and the number five cylinder button of the cylinder selection control depressed.

The cylinder may also be displayed at the top of the screen without being in the SHIFT condition by pressing all the buttons previously depressed but with the PATTERN POSITION control CONV button depressed. This display is shown in Figure **18 which is of a conventional ignition system.**

Raster Pattern

The raster pattern makes use of the vertical size of the scope screen by stacking the cylinder patterns one above the other. All individual patterns are vertically distributed on the screen.

This permits individual cylinder identification while viewing all cylinders at the same time. The raster pattern is especially helpful for cylinder identification of variations in the pattern waveforms observed in the superimposed pattern.

With the TRIGGER PICKUP clamped around number one spark plug wire, the number one cylinder will be displayed at the bottom of the screen. The remaining pattern waveforms will appear in the firing order sequence starting at the bottom and moving to the top of the scope screen.

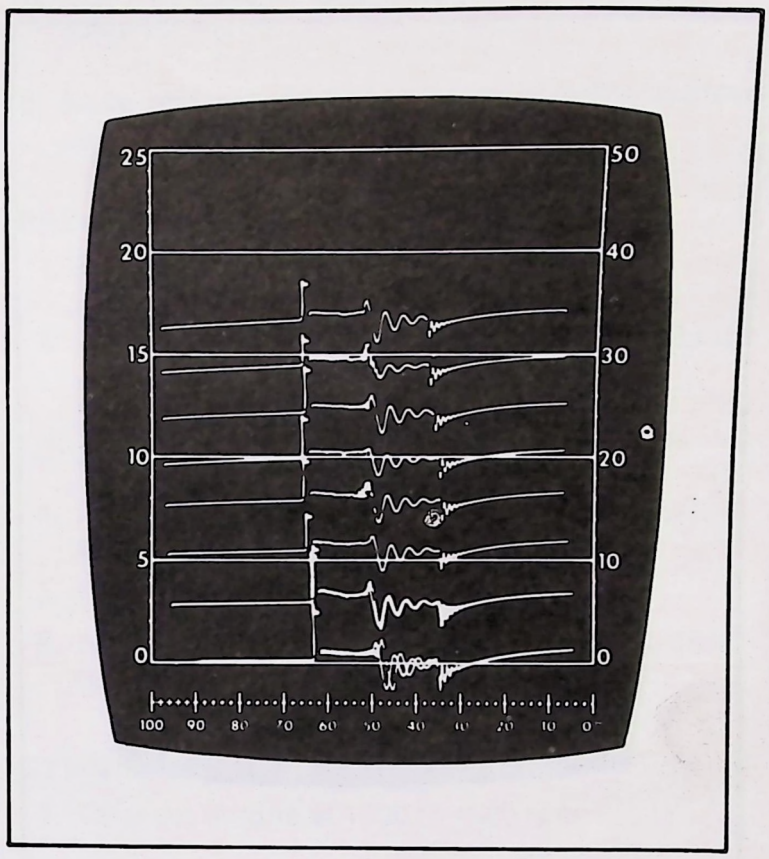


FIGURE 20 – A raster pattern in the shift position on an engine with conventional ignition.

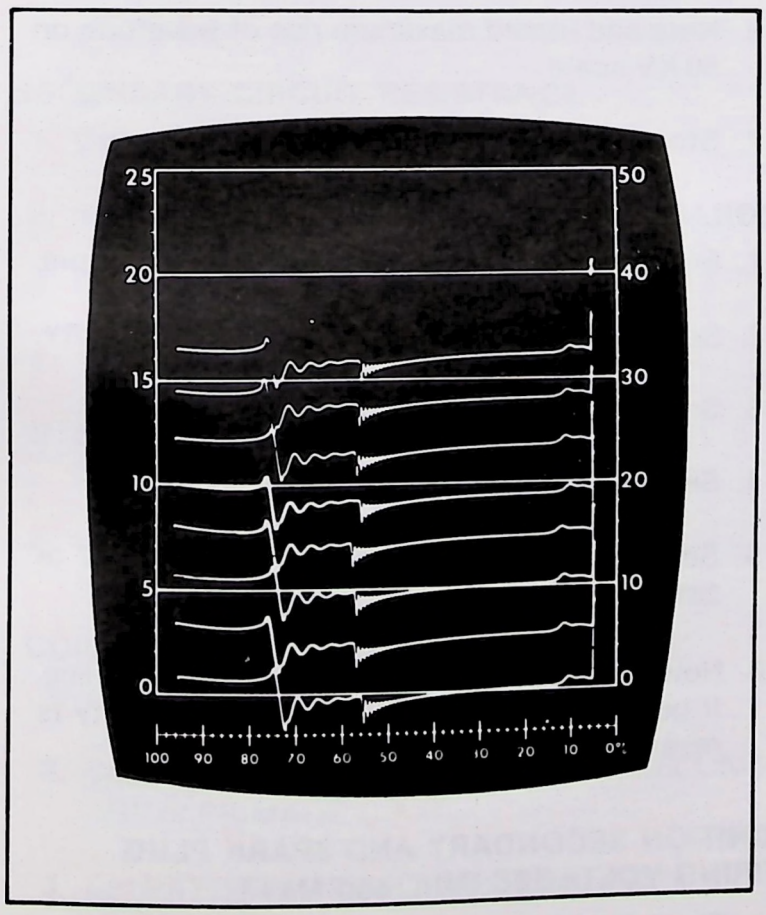


FIGURE 19 – A raster pattern of a normal operating engine with HEI ignition.

By setting the PATTERN SELECTOR knob at RASTER, the PATTERN HEIGHT knob at HIGH, the FUNCTION SELECTOR knob at SECONDARY, and the CONV button depressed, the scope will display a raster pattern (Figure **19**). The DISPLAY position of the PATTERN SELECTOR must be used for viewing the firing lines for measuring voltage potentials. The raster pattern in the SHIFT position does show the firing lines but this display is normally used for ease of viewing the cylinder patterns in raster. To get a raster pattern in the SHIFT position, **program the scope as above but press the SHIFT button (Figure 20).**

Superimposed Pattern

A superimposed pattern is the display obtained by placing all cylinder patterns one in front, or on top, of the other. Superimposed cylinder patterns provide a convenient method of testing an ignition system for overall uniformity. By having all cylinder display patterns one on top of the other, any variation of any individual cylinder pattern can be easily detected.

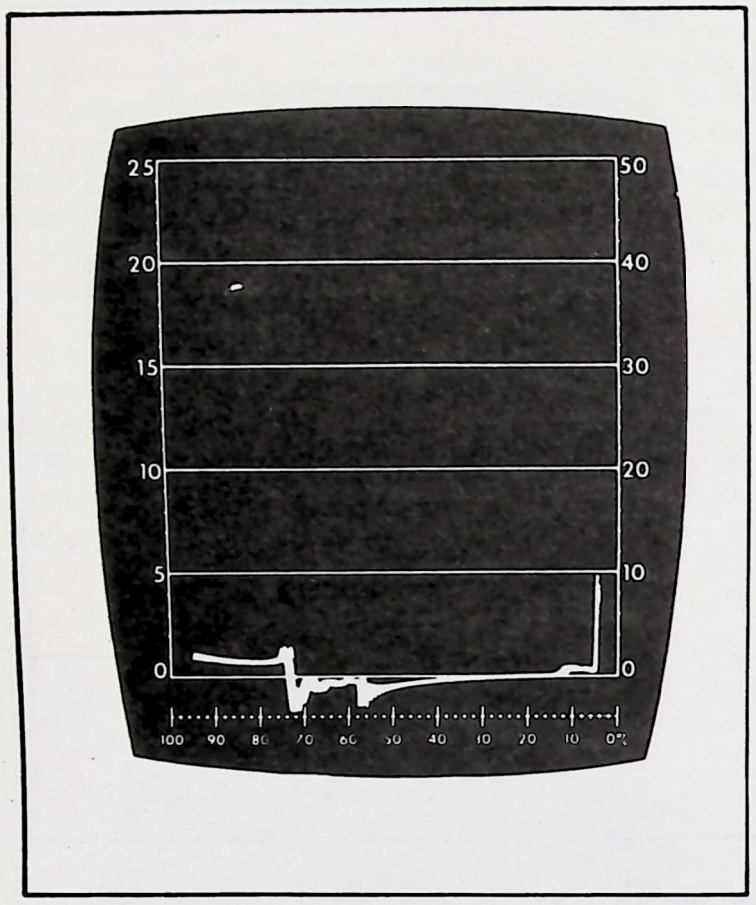


FIGURE 21 — A superimposed pattern of an engine with HEI ignition.

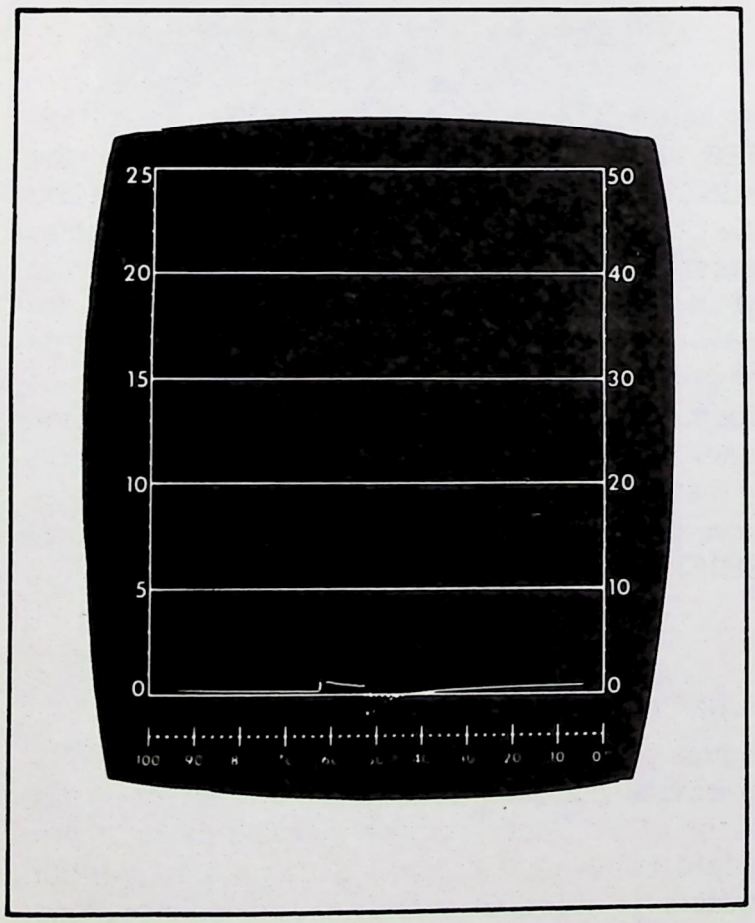


FIGURE 22— A single cylinder display obtained from superimposed pattern in compare (engine with Chrysler electronic ignition).

To obtain a secondary circuit superimposed pattern, set PATTERN SELECTOR to SUPERIMPOSE, PATTERN HEIGHT to HIGH, FUNCTION SELECTOR to SECONDARY, and push the CONV button on PATTERN POSITION controls **(Figure 21).** With the analog scope programmed for superimposed as above, a single cylinder display can be obtained by pushing the COMP button and one of the cylinder buttons on the CYLINDER SELECTOR. This gives a display of a single cylinder. The operator can view any single cylinder display by depressing the corresponding cylinder button on the CYLINDER SELECTOR. This cylinder will be displayed below the zero line on the dwell scale **(Figure 22).**

VEHICLE TESTING

COIL OUTPUT CRANKING

1. **Disconnect the coil secondary lead from the** center terminal of the distributor cap.
2. Set FUNCTION SELECTOR to SECONDARY.
3. Set PATTERN HEIGHT selector to HIGH.
4. Set PATTERN SELECTOR to DISPLAY.
5. **Crank engine with ignition key ON.**
6. Note and record maximum rise of waveform on 50 KV scale.
7. Stop cranking and reconnect coil lead.

COIL POLARITY

1. Start engine and operate at 1000 to 1500 rpm.
2. Set FUNCTION SELECTOR to SECONDARY.
3. Set PATTERN HEIGHT selector to LOW.
4. Set PATTERN SELECTOR to DISPLAY.
5. Set PATTERN POSITION for either CONV or SHIFT.
6. Note and record position of waveform firing line. If pattern is upside down, the coil polarity is reversed.

IGNITION SECONDARY AND SPARK PLUG FIRING VOLTAGES (Min. and Max.)

1. Operate engine at 1000 to 1500 rpm.
2. Set FUNCTION SELECTOR to SECONDARY.

3. Set PATTERN HEIGHT selector to LOW.
4. Set PATTERN SELECTOR to DISPLAY.
5. Set PATTERN POSITION for either CONV or SHIFT.
6. Note and record the height of each firing line **on the 25 kV scale.**

MAXIMUM COIL OUTPUT

1. Operate engine at 1000 to 1500 rpm.
2. Set FUNCTION SELECTOR to SECONDARY.
3. Set PATTERN HEIGHT selector to HIGH.
4. Set PATTERN SELECTOR to DISPLAY.
5. Set PATTERN POSITION for either CONV. or SHIFT.
6. Use insulated pliers to disconnect one spark plug wire and hold wire away from engine **ground. (See manufacturer's special cautions on electronic ignition system vehicles.)**
7. **Note and record maximum rise of waveform on** 50 KV scale .
8. Reconnect spark plug wire to spark plug.

SECONDARY CIRCUIT RESISTANCE

1. Operate engine at 1000 to 1500 rpm.
2. Set FUNCTION SELECTOR to SECONDARY.
3. Set PATTERN HEIGHT selector to LOW.
4. Set PATTERN SELECTOR to RASTER.
5. Set PATTERN POSITION for either CONV or SHIFT.
6. Note and record the appearance of each waveform spark line.

COIL AND CONDENSER ACTION

1. Operate engine at 1000 to 1500 rpm.
2. Set FUNCTION SELECTOR to either SECONDARY or PRIMARY.
3. Set PATTERN HEIGHT selector to HIGH.
4. Set PATTERN SELECTOR to RASTER or SUPERIMPOSE.
5. Set PATTERN POSITION *for either CONV or* SHIFT.
6. **Note and record appearance of intermediate section waveform.**

BREAKER POINT CONDITION

1. Operate engine at 1000 to 1500 rpm.
2. Set FUNCTION SELECTOR to either PRIMARY or SECONDARY.
3. Set PATTERN HEIGHT selector to LOW.
4. Set PATTERN SELECTOR to RASTER or SUPERIMPOSE.
5. Set PATTERN POSITION for SHIFT.
6. **Note and record point open and point close portion of dwell section.**

CYLINDER TIMING ACCURACY

1. Operate engine at 1000 to 1500 rpm.
2. Set FUNCTION SELECTOR to either PRIMARY or SECONDARY.
3. Set PATTERN HEIGHT selector to LOW.
4. Set PATTERN SELECTOR to SUPERIMPOSE.
5. Set PATTERN POSITION for SHIFT.
6. Note and record the misalignment in degrees of the waveform point open signals.

SNAP ACCELERATION

1. Operate engine at idle.
2. Set FUNCTION SELECTOR to SECONDARY.
3. Set PATTERN HEIGHT selector to HIGH.
4. Set PATTERN SELECTOR to DISPLAY.
5. Set PATTERN POSITION for CONV.
6. Snap accelerate engine to approximately 2000 rpm; then release throttle.
7. Note and record maximum and minimum rise of firing lines on the 50 KV scale.

CYLINDER COMPARISON

Occasionally it becomes desirable to enlarge a particular waveform for detailed comparison with the others being viewed on the screen. This is easily **accomplished when viewing either secondary or primary patterns in the following manner.**

Analog Scope Testing

1. Operate the engine at the desired test speed.
2. Set the FUNCTION SELECTOR to either SECONDARY or PRIMARY as desired.
3. Set the PATTERN HEIGHT selector to HIGH.
4. Set the PATTERN SELECTOR to DISPLAY.
5. Set the PATTERN POSITION for either CONV or SHIFT as Jesired.
6. Push the COMP button of the CYLINDER SELECTOR MODE control.
7. Select the cylinder to be compared with the others and depress the corresponding button of the CYLINDER SELECTOR.
8. Compare the characteristics of the enlarged waveform at the top of the screen with the other waveforms being displayed.
9. Press the same CYLINDER SELECTOR button, or the CANCEL button to return the enlarged waveform to its former position in the display.
10. Repeat steps 7, 8 & 9 to enlarge any of the other cylinder waveforms for comparison.
11. Push two or more CYLINDER SELECTOR buttons and compare the cylinder waveforms. They will be superimposed at the top of the screen.

ALTERNATOR DIODE TEST

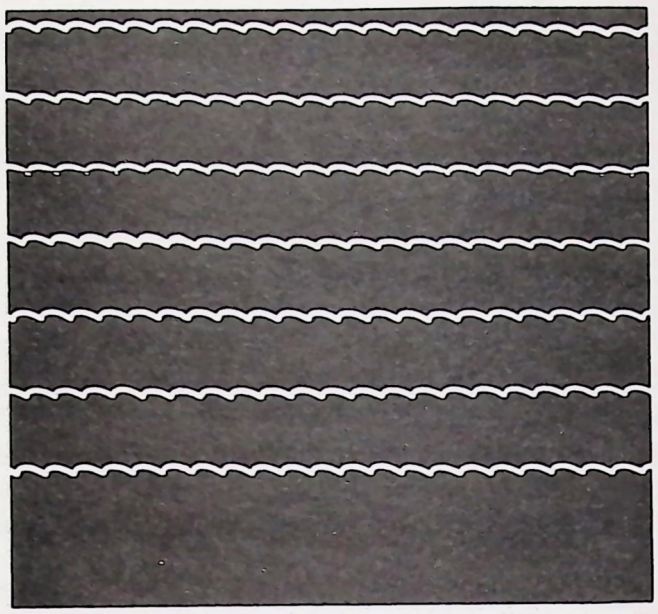
1. Turn PATTERN SELECTOR knob to the RASTER position and set PATTERN HEIGHT knob to VARIABLE.
2. Turn VARIABLE knob fully clockwise.
3. Turn FUNCTION SELECTOR knob to SPECIAL PATTERNS position.
4. Connect test leads.

   a. Clamp the Chrome PATTERN PICKUP around the coil high tension wire, and connect PRIMARY PICKUP, Red to distributor side of coil and Black to ground.

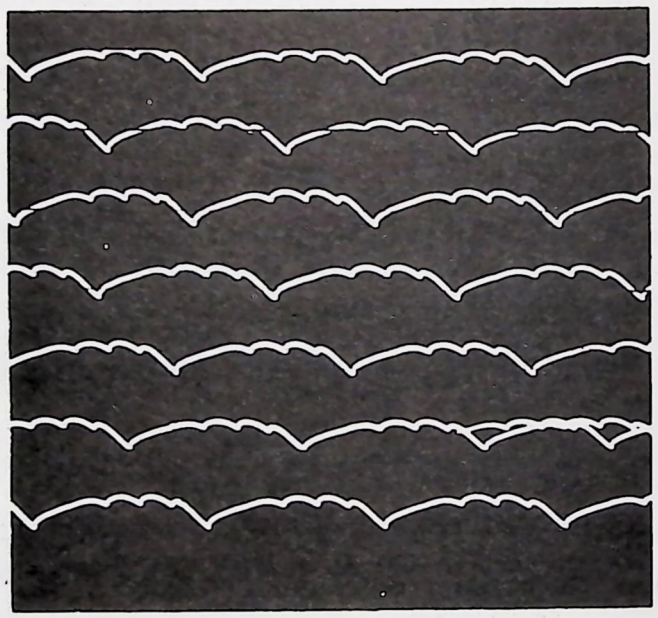
   b. Clamp the Green SPECIAL PATTERNS PICKUP around the alternator output (+) lead or to the positive battery cable.

5. Start the engine and operate at approximately 1000 rpm.
6. Turn headlights on and to high beam to apply an electrical load to the alternator.
7. Observe waveform and compare to Figure 23.

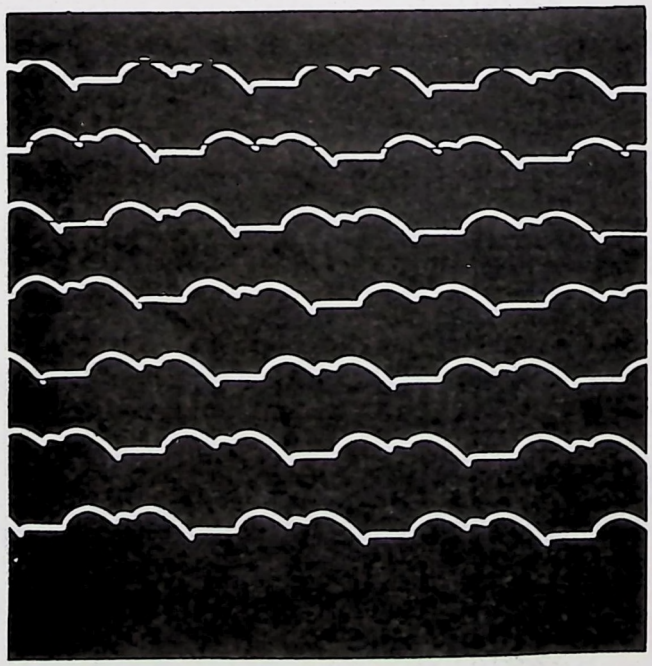
   If waveform is other than normal, alternator should be removed from vehicle for service or replacement.



Normal Alternator



Open Diode



Shorted Diode

FIGURE 23 — Normal and abnormal alternator output waveforms.

ELECTRONIC IGNITION SCOPE TESTING

Most electronic ignition systems are tested in a manner similar to the procedure followed when testing standard systems. The following gives test connections for electronic ignition systems.

The American Motors and Jeep early model electronic systems are called Breakerless Inductive Discharge (BID) ignition systems. AMC late models use the Ford electronic ignition system. The scope test connections to the BID and AMC/Ford systems are the same as for a standard ignition system as follows:

1. Clamp the Chrome PATTERN PICKUP around the secondary coil wire.
2. Clamp the Red TRIGGER PICKUP around the No. 1 spark plug wire near the distributor cap.
3. Connect the Red Dwell to the coil negative terminal.
4. Connect the Black Dwell Lead to a good engine ground.

Chrysler has two electronic ignition systems, the Chrysler Electronic Ignition system and the Chrysler Electronic Spark Advance System. The scope test connections to both systems are the same as for standard systems. Standard connections are listed for American Motors above.

NOTE: The distinguishing feature of the Chrysler Electronic Ignition waveform figure on the scope is that an Intermediate Section does not appear.

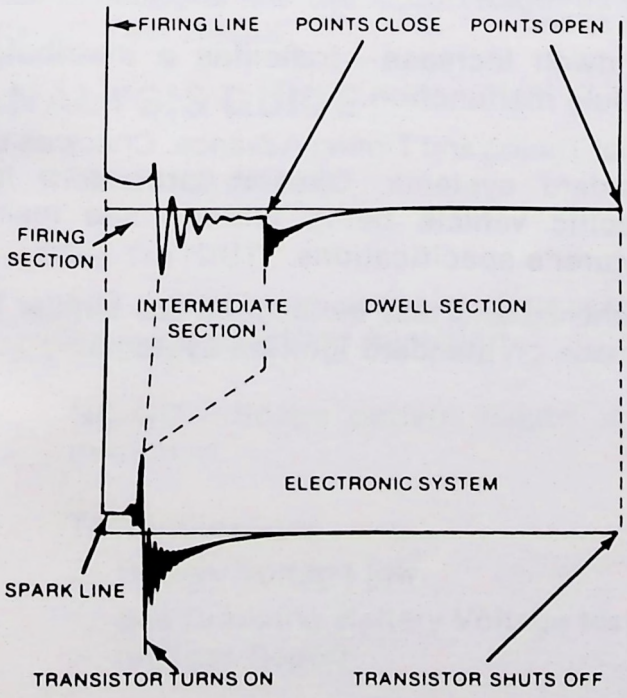


FIGURE 24 — Scope pattern comparisons between a conventional system and Chrysler electronic system.

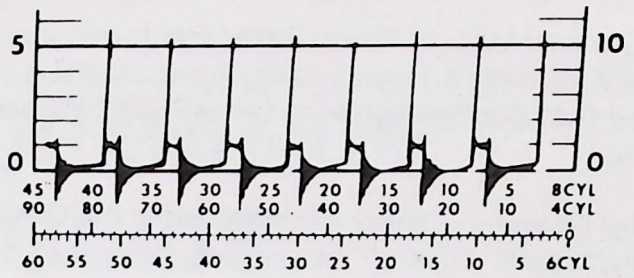
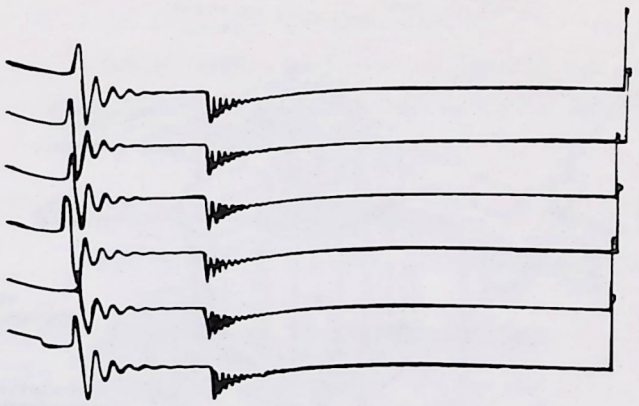


FIGURE 25— Chrysler electronic eight cylinder scope display.

Ford's electronic ignition system is called Ford Solid State Ignition DURA-SPARK I, II, etc. The scope connections to Solid State Ignition are the same as for standard systems as listed for American Motors above, except that the Red Dwell lead is connected to a terminal marked TACH TEST (coil negative) on the coil connector.



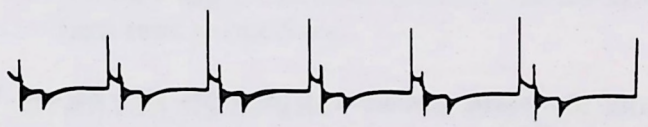


FIGURE 26 — Raster and display patterns for Ford six cylinder Solid State Ignition System.

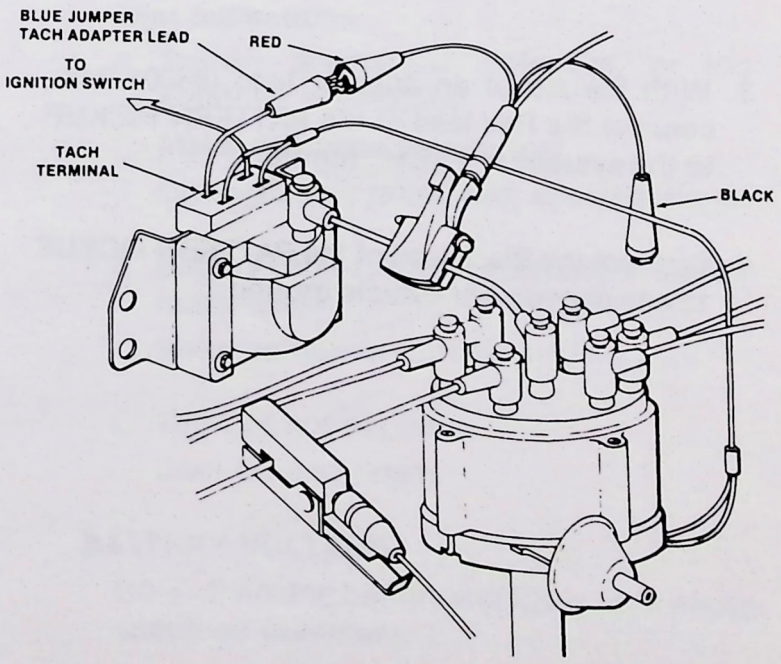


FIGURE 27—Tester connections on Delco HEI L6 and 4 cylinder ignitions.

Analog Scope Testing

The General Motors Delco Remy electronic ignition system is called High Energy Ignition (HEI). The scope test connections for the HEI system are as follows:

1. For L6 and 4 cylinder engines, clamp the Chrome PATTERN PICKUP around the secondary coil wire (Figure 27).

For V8, V6, and late model 4 cylinder engines, snap the HEI adapter into place on top of the coil cover (Figure 28).

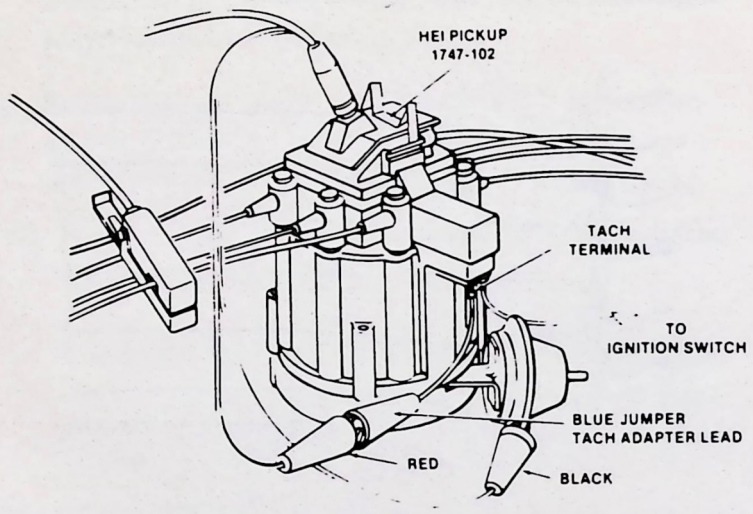


FIGURE 28—Tester connections on Delco HEI V8 and V6 cylinder ignitions.

2. Clamp the Red TRIGGER PICKUP around the No. 1 spark plug wire near the distributor.

3. With the aid of an adapter lead (#6002-048), connect the Red lead of the PATTERN PICKUP to the system's "TACH" terminal.

4. Connect the Black lead of the PATTERN PICKUP to any convenient vehicle ground.

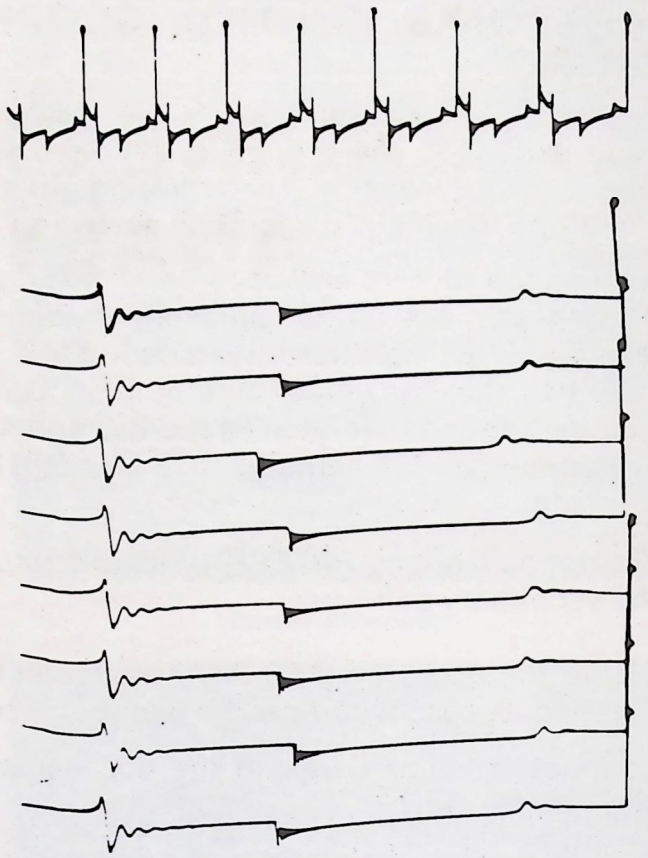


FIGURE 29 — Raster and display patterns for General Motors V-8 HEI system.

HEI TESTING INFORMATION

1. Start engine, allow to stabilize within the normal operating temperature range.
2. Dwell check.

   Run engine at idle speed and observe dwell reading on scope.

   Slowly accelerate engine to 2000 rpm. Dwell should extend in relationship to engine speed and should be considerably greater than at idle speed.

   No dwell increase — indicates a distributor module malfunction.
3. Initial Timing and Timing Advance. Check as on standard systems. Observe procedure for **specific vehicle being tested — see manufacturer's specifications.**

Scope checks and test indications are similar to those made on standard ignition systems.

ENGINE PERFORMANCE ANALYSIS GUIDE

AREA PERFORMANCE TEST ANALYSIS

Analyzing the results on the Engine Performance Test Report requires comparing the test results with manufacturer's specifications to determine which tests to mark NO-GO. Analyzing all of the tests marked NO-GO is the basis for determining what engine areas have problems, what specific Pinpoint Tests to perform, and what service recommendations to make.

The Sun Specification cards, underhood stickers and manufacturer's manuals and bulletins are used to obtain the specifications needed. Where no factory specifications are furnished, the technician must base his decision (GO or NO-GO) on what is normal for good engines of the make and model being tested based on past experience.

The following Analysis Guide lists the GO and NO-GO considerations and shows the most common Test Indications and the Action Required for each NO-GO Test Result.

ANALYSIS GUIDE

1. CRANKING MODE

COIL OUTPUT

GO — Height of scope pattern reaches or exceeds specified minimum.

NO-GO — Scope pattern height is below minimum.

Test Indications:

a. Battery voltage low.
   See Cranking Battery Voltage test result on Test Report.

b. Dwell too low.
   See result of dwell test in Idle Mode.

c. Bypass circuit bad.
   Test bypass circuit with voltmeter.

d. Low primary ignition current.
   Check with ammeter. Check for resistance in primary circuit and points. Check for possibility of wrong coil.

e. Coil or condenser bad.
   Test with Sun coil and condenser testers.

f. Bad coil wire to distributor cap.
   Test with ohmmeter.

NOTE: On electronic ignition, follow specified test procedure.

STARTER CURRENT

GO — Starter Current draw is not more than specified maximum.

NO-GO — Starter current draw is too high.

Test Indications:

a. Battery discharged, defective, or too small for application.
   Make complete battery test.
   Check battery rating with specifications.

b. Battery cables, starter solenoid or starter motor bad.
   Make complete starting system test.

c. Tight or hot engine.
   Cool off and retest.

BATTERY VOLTAGE

Go — Cranking battery voltage is at or above specified minimum.

NO-GO — Voltage is below specified minimum.

Test Indications:

a. Same test indications as Starter Current.

ENGINE VACUUM

GO — Vacuum reading steady at normal level.

NO-GO - Vacuum reading uneven or much lower than normal.

Test Indications:

a. Vacuum leaks.

(1) Examine all vacuum hoses including emission controls and accessories.

(2) Tighten engine manifold bolts, carburetor mounting bolts, etc.

b. Engine mechanical condition.

Test with cylinder leakage tester and compression tester.

2. CHARGING MODE

CHARGING SYSTEM

GO — Ammeter reading shows alternator is charging at least half of rated output, and alternator waveform on scope is normal.

NO-GO — Ammeter shows low output or no charge or alternator waveform on scope is abnormal.

NOTE: In most cases, when the alternator output is checked after making cranking tests, the ammeter reading seen at the instant the engine is started and "revved up" will be well over half of rated output. However, the condition of the battery, the length of time the engine was cranked and the speed the engine reached all can affect this reading.

Test Indications:

a. Fan belt loose or worn out.

Check and correct as necessary.

b. Accessory load very high.

Check current draw with key on. Add this reading to output obtained. Compare to specifications.

c. Alternator defective.

Check alternator output with amps pick-up at alternator and all accessories on.

d. Voltage regulator defective.

Use Starting and Charging System tester, bypass regulator and check alternator output.

DIODE STATOR

GO — Scope shows even ripple.

NO-GO — Scope shows uneven ripple.

Test Indications:

a. Output diodes or stator bad.

Remove and disassemble alternator and test components.

3. IDLE MODE

REVOLUTIONS PER MINUTE (RPM)

GO — Meets manufacturer's specified idle speed at specified test condition.

NO-GO — Idle speed not set to specifications.

Test Indications:

a. Carburetor idle speed and/or mixture screws not properly adjusted.

Correct as necessary.

b. Choke sticking or not fully open.

Correct as necessary.

c. Idle solenoid not adjusted correctly, if so equipped.

Correct as necessary.

d. Test not made under specified conditions. See specifications and under hood sticker.

Test as specified.

e. Mechanical Engine Condition.

Check all test results for indications of problems like fouled plugs, weak cylinders, etc.

f. Bad emission control devices, especially EGR valve.

Test and service per factory recommendations.

DWELL

GO — Dwell is within specifications.

NO-GO — Dwell is too high or too low.

Test Indications:

a. Ignition points improperly adjusted.
Reset to spec.

b. Distributor defective.
Make complete distributor test on Sun Distributor Tester.

NOTE: On electronic ignition, see manufacturer's recommendations.

INITIAL TIMING

GO — Timing set to specifications.

NO-GO — Timing is too early or too late.

Test Indications:

a. Timing not adjusted properly.
Reset to specifications.

b. Distributor advance mechanism bad.
Remove and test distributor on Sun Distributor Tester.

c. Engine not running at proper speed.
Vacuum retard not disconnected during test, if so specified.

NOTE: Timing must be adjusted according to specified procedure at specified rpm after dwell is set correctly.

CARBON MONOXIDE AT IDLE

GO — CO readings within specifications.

NO-GO — CO readings out of specifications.

Test Indications:

a. Carburetor settings incorrect.
Correct as necessary.

b. Wrong float adjustment.
Adjust as necessary.

c. Dirty air cleaner.
Clear or replace element.

d. Improper idle speed.
Adjust as necessary.

e. Oil in crankcase diluted with gasoline or excessive engine blow-by.
Correct as necessary.

HYDROCARBON AT IDLE

GO — HC within specifications.

NO-GO — HC readings out of specifications.

Test Indications:

a. Engine mechanical problems indicated.
Service and repair as necessary.

b. Ignition problems indicated.
Test and service ignition system.

ENGINE VACUUM

GO — Steady at or above specified minimum.

NO-GO — Unsteady or below specified minimum.

Test Indications:

a. Same test indications as for cranking engine vacuum.

POSITIVE CRANKCASE VENTILATION (PCV)

GO — Engine rpm, CO or vacuum changes as specified when PCV is plugged.

NO-GO — Rpm, CO or vacuum does not change when PCV is plugged.

Test Indications:

a. PCV valve is plugged or defective.
Clean or replace and retest.

b. PCV hose or vacuum source is plugged or hose is cracked.
Repair as needed.

c. Wrong PCV valve.
Replace with correct one.

4. 1200 RPM LOW CRUISE MODE

COIL POLARITY

GO — Pattern right side up.

NO-GO — Pattern inverted (firing lines extend downward).

Test Indications:

a. Ignition coil primary wires reversed. (Should match battery ground polarity.)
Check and correct as necessary.
Make sure coil is correct one.

b. Battery installed backwards or charged backwards.

Check with voltmeter.

Correct as required.

SPARK PLUGS

GO — Firing voltages even within 3 kV and normal for engine being tested.

NO-GO — Firing voltages vary more than 3 kV All firing lines excessively high or excessively low.

Test Indications:

a. Spark plug or rotor gaps not correct.

Bad resistor spark plugs. Rotor, distributor or wires defective.

Use grounding probe to pinpoint cause of high readings, visual inspection for narrow plug or rotor gaps.

b. Fuel mixture incorrect.

Check choke and carburetor adjustment.

Check for vacuum leaks.

c. Timing or advance incorrect.

See Initial Timing test results in idle mode, Timing Advamce test results in high cruise mode.

d. Electronic distributor trigger coil connected wrong.

Reverse connections and retest.

MAXIMUM COIL OUTPUT

GO — Reaches or exceeds specified minimum.

NO-GO — Output is less than minimum specified.

Test Indications:

a. Dwell too low.

See Dwell Test Results in idle mode and high cruise mode.

b. Excessive resistance in ignition switch, primary circuit or points.

Check with voltmeter, ohmmeter.

c. Low voltage due to charging system problem.

See Charging Volts Test results in high cruise mode.

d. Insulation bad in secondary circuit.

If coil output is under 25 kV and lower extent of waveform is intermittent or missing, test for insulation breakdown in wires, cap, or rotor.

e. Coil or condenser defective.

Test and replace as needed.

SECONDARY INSULATION

GO — Lower extent of coil waveform (down-spike) is steady and equal to about one half of upward extent.

NOTE: This does not apply to high output systems such as HEI that produce over 30 kV since the spark will jump inside the distributor cap on good systems.

NO-GO — Coil output is less than 25 kV and the down-spike is intermittent or missing.

Test Indications:

a. Wires, cap, rotor, or coil bad.

Make secondary insulation test of all cylinders to isolate problem.

SECONDARY RESISTANCE

GO — Length and slope of spark lines is normal for engine being tested.

NO-GO — One or more spark lines slants excessively and is too short.

Test Indications:

a. Excessive resistance in plugs, wires, rotor, or distributor cap, or coil tower.

Isolate problem using grounding probe.

COIL-CONDENSER

GO — Normal number and size of oscillations in intermediate section.
NO-GO — Oscillations diminished or missing in intermediate section.

Test Indications:

a. Coil or condenser defective.

Test and replace as necessary.

b. Points, condenser, or ground pigtail loose in distributor.

Make complete distributor test.

NOTE: Some ignition systems such as Chrysler Electronic Ignition will not show oscillations.

BREAKER POINTS

GO — Point close and point open signal normal.

NO-GO — Point close or point open signal irregular or shows arcing.

Test Indications:

a. Dirty, burned, or misaligned points.
Replace points, test condenser.

b. Weak point spring tension.
Replace points, adjust spring tension.

c. Dwell too high or primary current too high.
Check dwell, measure primary current, correct as necessary.

d. Wrong coil or ballast resistor.
Check and correct as needed.

e. Charging voltage incorrect.
See test result in high cruise mode.

CYLINDER TIMING

GO — Point open signals even within specifications.

NO-GO — Point open signals vary more than specified (usually ±2°).

Test Indications:

a. Distributor cam defective.
Remove and test distributor in Sun Distributor Tester.

b. Breaker plate or bushings worn or defective. Wrong point spring tension. Remove and test distributor in Distributor Tester.

c. Problem in engine such as bad distributor bushing in block or loose timing chain.
Check and repair as needed.

CARBON MONOXIDE AT LOW CRUISE

GO — CO readings within specifications or slightly less than idle CO.

NO-GO — CO readings out of specifications.

Test Indications:

Same as for Idle CO.

HYDROCARBON AT LOW CRUISE

GO — HC reading within specifications.

NO-GO — HC readings out of specifications.

Test Indications:

Same as for Idle HC.

5. CYLINDER POWER BALANCE MODE

GO — Rpm with each cylinder shorted dropped approximately the same amount.

NOTE: Amount of drop and allowable variation depends upon type of engine, number of cylinders, and speed at which test was made.

NO-GO — Rpm does not change or changes very little on one or more cylinders.

Test Indications:

a. Ignition problems.
Check results of scope tests in low cruise mode.

b. Engine problems.
Check compression and cylinder leakage.

c. Fuel mixture or distribution problems.
Check for vacuum leaks.
Check carburetor adjustment and balance.

6. SNAP ACCELERATION MODE

PLUGS UNDER LOAD

GO — Firing lines increase moderately and evenly and firing voltages do not exceed maximum specified.

NO-GO — Firing lines do not increase evenly or firing voltages exceed maximum specified.

Test Indications:

a. Spark plugs worn out, gapped wrong, or are fouling out.
Clean and regap or replace as required.

b. Lean fuel mixtures.
Check carburetor accelerator pump and high speed circuit.

7. 2500 RPM HIGH CRUISE MODE

TIMING ADVANCE

GO — Timing is advanced specified amount.

NO-GO — Timing advance too little or too much.

Test Indications:

NOTE: These tests can be done with a Distributor Tester.

a. Vacuum advance chamber is leaking or inoperative.
   (1) Check vacuum chamber with external vacuum source.
   (2) If vehicle is equipped with transmission controlled spark, recheck advance as specified for this type of system.
   (3) Check vacuum supply to distributor advance unit.

b. Mechanical advance sticking or inoperative.
   Disconnect vacuum advance and repeat advance test.
   This checks mechanical advance only.
   Remove and repair distributor.

c. Wrong distributor for engine.
   See specifications.

DWELL

GO — Dwell reading does not change more than specified from dwell at idle.

NO-GO — Dwell reading changed more than allowable for system being tested.

NOTE: Some electronic ignition systems incorporate a dwell change in the design. See specifications and recommendations for system being tested.

Test Indications:

a. Distributor in poor mechanical condition.
   Remove and test in distributor tester.
   Repair as needed.

CHARGING VOLTS

GO — Voltmeter reading within specifications.

NO-GO — Voltage higher or lower than specified.

Test Indications:

a. Make complete charging system test with Starting and Charging system tester.

CARBON MONOXIDE

GO — CO reading within specifications and less than at idle.

NO-GO — CO reading not within specifications.

Test Indications:

a. Plugged air bleeds or restricted air cleaner.
   Unplug and/or replace.

b. Incorrect metering rod adjustment or incorrect metering jets.
   Adjust or replace as required.

c. Leaky power valve, accelerator pump or check valve.
   Correct as necessary.

d. High float level.
   Adjust as required.

HYDROCARBON

GO — HC reading within specifications.

NO-GO — HC reading not within specification.

Test Indications:

a. Plugged high speed passages or jets.
   Unplug as required.

b. Incorrect metering jets or metering rod adjustment.
   Adjust or replace as needed.

c. Manifold or carburetor air leaks.
   Service as necessary.

d. Low float level.
   Adjust as required.

e. Ignition system problem.
   Test and service as necessary.

ENGINE VACUUM

GO — Reading steady and higher than at idle.

NO-GO — Vacuum unsteady or lower than at idle.

Test Indications:

a. Engine problems.
Check cylinder power balance test results.

b. Exhaust system restricted.

c. Timing not advancing properly.
Check results of timing advance test.

METER AND GAUGE TESTING

RPM X 100 TACHOMETER

NOTE: Testing procedures for the meters and gauges are presented in this section. For a complete presentation of automotive testing, which includes meter and gauge testing, refer to Sun's Automotive Testing And Diagnosis manual.

Revolutions per minute (rpm) can be measured from 0 to 12000 rpm. With the AMPERES-DWELL-RPM knob in the AUTO-TACH/DWELL position, the Red 0-1500 and the Blue 0-6000 scales are activated. Engine speed determines which scale applies and which indicator lamp is lit. When engine rpm is in the 0-1500 range, the 1500 RPM indicator lamp will light. When engine rpm is in the 0-6000 range, the 6000 RPM indicator lamp will light. With the AMPERES-DWELL-RPM knob in the 12000 RPM/DWELL position, only the Blue 0-12000 scale and the 0-12000 RPM indicator lamp are activated.

TEST CONNECTIONS

1. Clamp the Red TRIGGER PICKUP onto the wire lead of the timing spark plug (normally No. 1 in the firing order).

2. Set NO. OF CYLINDER control to match the number of cylinders of engine being tested.

3. Push CYCLE button 2 or 4 to match the type of ignition system being tested.

Tachometer **readings** can be obtained from the primary as well, by connecting the Red Boot of the Blue lead to the distributor side of the coil, and the Black Boot to ground.

CYLINDER POWER BALANCE TEST

The power balance test provides a means of shorting out cylinders individually or in combinations to determine how well the engine runs with the remaining cylinders. This test compares the change in engine rpm with one cylinder at a time or with similar groups of cylinders shorted. The test results indicate whether or not any cylinder or combination of cylinders is developing its share of drive power.

The less power produced by a given cylinder, the less rpm will be lost when that cylinder is shorted out.

Shorting in Pairs

Shorting in pairs is primarily used on 4-cylinder engines.

1. Start engine and operate at approximately 1000 rpm. (If attempting to troubleshoot a specific performance problem, operate engine at speed where problem is most noticeable.)

2. Push CANCEL button of the CYLINDER SELECTOR controls.

3. Push 1 and 3 buttons of CYLINDER SELECTOR controls. Then push the CYLINDER SELECT MODE SHORT button.

   NOTE: The operator has 20 seconds to record a data reading. The SHORT button should be cancelled after approximately 20 seconds.

4. Note and record rpm with cylinders shorted.

5. Perform Steps 2, 3, and 4 with buttons 2 and 4 depressed.

6. Push the CANCEL button. Allow engine base speed to stabilize, and then record engine base speed.

   NOTE: The individual rpm readings must be subtracted from the base rpm to find the change in rpm. The weak cylinders are those

with the least amount of change in rpm when they are shorted out.

7. Record and evaluate the test data.

Shorting In Combinations

This test is applicable on engines with any number of cylinders.

CAUTION: On cars with catalytic converters, consult manufacturer's instructions telling how many cylinders can be safely shorted out at one time.

The method of doing the power balance test is given under the heading, Shorting In Pairs. Other tests can be devised for shorting other combinations of cylinders, but the test procedure must conform to the test steps under Shorting In Pairs.

When testing with odd or even cylinders shorted, for example, follow the procedure under Shorting In Pairs, except short the odd numbered cylinders first and get an rpm reading. Then, short the even numbered cylinders and get an rpm reading.

Compare the engine rpm results to see if the two groups of cylinders are balanced.

The combinations of cylinders that can be shorted are many and varied. The operator can create many test combinations to fit his testing needs, provided he follows the method of operating the tester as demonstrated under Shorting In Pairs.

CARBURETOR POWER BALANCE TEST

This test procedure works well on most standard production V-8 engines. However, there may be some high performance engines or special intake manifolds that follow a different fuel distribution pattern.

1. Identify each engine cylinder by number on an engine chart. Cylinder numbers are identified on Sun Specification Cards and in manufacturer's engine service manuals.

NOTE: The cylinders may be numbered like many American Motors, Chrysler and General Motors engines (Figure 30). One, three, five and seven are in the left bank, and two, four, six and eight are in the right bank, and fire in the sequence of 1, 8, 4, 3, 6, 5, 7, 2. By writing the firing order in the space provided below the Power Balance buttons, it can be readily seen that depressing the odd numbered buttons will short out the four cylinders (1, 4, 6 and 7) being fed from the left barrel of the carburetor (Figure 31). On the other hand, if the even numbered buttons are depressed, the cylinders fed by the right barrel (2, 3, 5 and 8) will be shorted out.

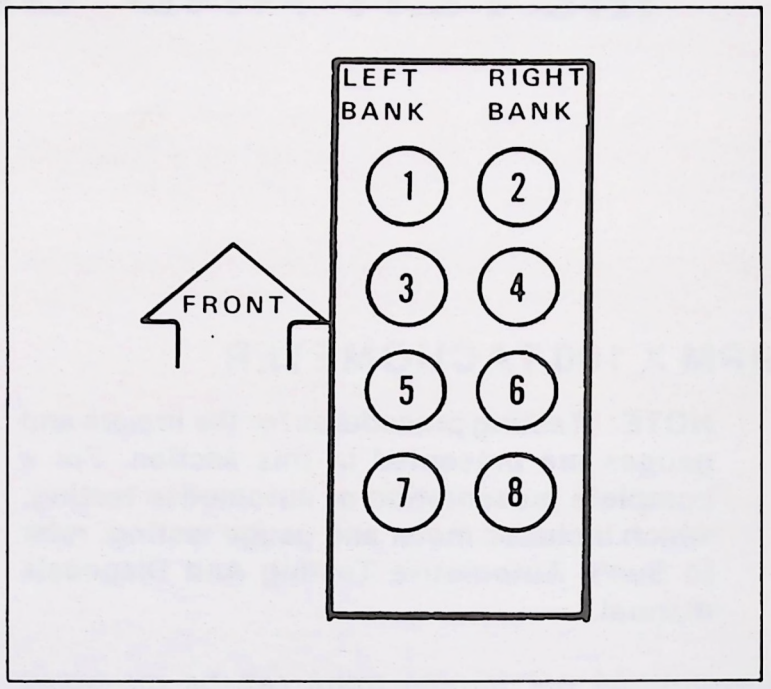


FIGURE 30 — One method used in numbering cylinders.

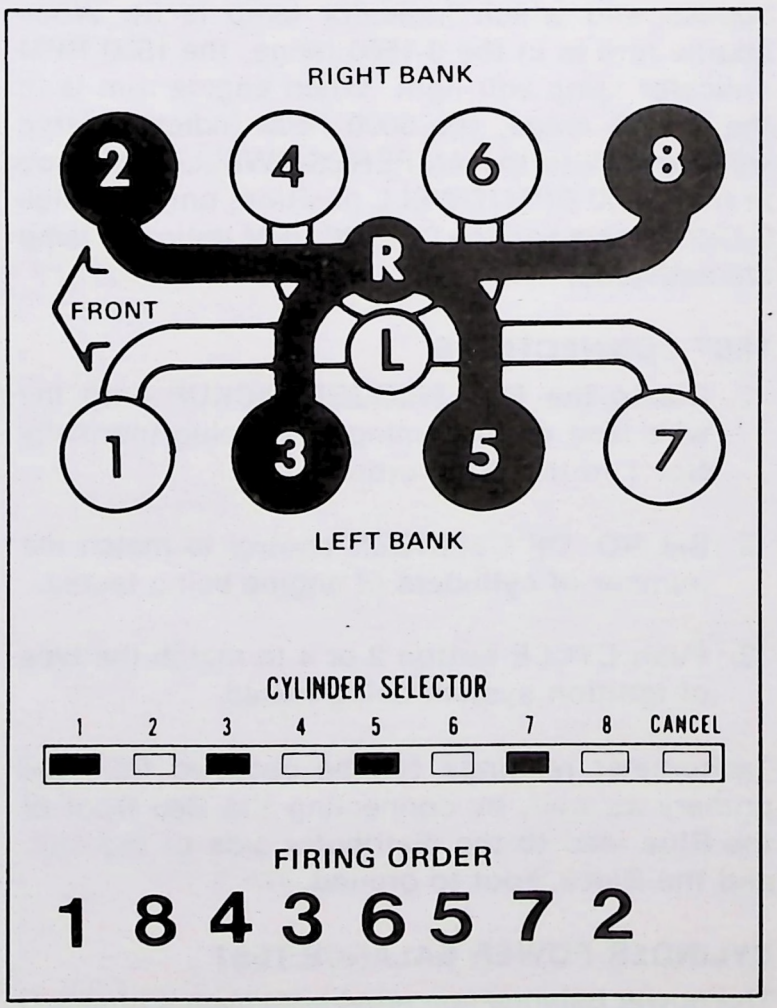


FIGURE 31 — The cylinders fed by the left and right carburetor barrels related to the cylinder power balance buttons and the firing order of one engine.

2. Turn the engine at test speed.

3. Short out the "even" half of the cylinders and note the engine rpm. The Power Balance function of the tester is used for this test. The Power Balance Test has been explained previously.

   CAUTION: On vehicles equipped with catalytic converters, do not run for more than 20 seconds at a time with four cylinders shorted.

4. Short out the "odd" half of the cylinders and note the engine rpm.

5. Compare these engine speeds and adjust carburetor as required.

   NOTE: Be sure engine is mechanically sound. An unsound engine will give erroneous readings on the Carburetor Balance Test.

   Testing for mechanical soundness of engines is as follows:

   1. Short out 4 cylinders (one bank on GM 1, 3, 5 & 7).
      Note rpm reading.
   2. Short out other bank (2, 4, 6 & 8). Note rpm reading. Rpm should be even within 10 rpm in order to achieve good carburetor balance.

IDLE SPEED

Follow manufacturer's procedure for setting engine idle speed. The type of engine, transmission and accessories installed will frequently determine the correct idle speed.

1. With tester connected, start engine and run until it is at normal operating temperature (choke open).

2. Place transmission and accessories in the operating condition indicated by manufacturer's specifications for Idle Speed Test (for example: automatic transmission in Drive, air conditioning ON).

3. Observe engine rpm and compare with manufacturer's specifications for idle speed.

POSITIVE CRANKCASE VENTILATION TEST

A test of the PCV system can be conducted by closing off the system at a point prior to its connection by the intake manifold and noting the change in engine rpm.

1. Place at idle rpm and normal operating temperature (choke fully open).

2. Close off or plug the PCV hose to the intake manifold.

3. Observe the tachometer for change in engine speed.

   a. Engine speed decreases by 50 rpm or more (unless otherwise specified by manufacturer) — indicates PCV operation normal.

   b. Engine speed does not change — indicates PCV valve, hoses, or air intake clogged.

   NOTE: See other PCV tests, such as Vacuum and CO tests.

DWELL-AMPS METER

The DWELL-AMPS meter is used to measure dwell, current and distributor resistance. With the AMPERES-DWELL-RPM knob in the AUTO-TACH/DWELL or the 12000 RPM/DWELL position, the Red dwell scale is activated. The dwell meter measures and registers the average dwell for all cylinders in terms of degrees of distributor cam rotation.

DWELL TEST CONNECTIONS

1. Connect and prepare the tachometer as outlined in RPM x 100 Tachometer section.

2. Connect Red primary pickup lead to the coil primary terminal on the distributor.

3. Connect the Black primary pickup lead to engine ground.

Dwell Test

1. Operate engine at idle speed.

2. Observe the indication on the Red dwell meter scale. Compare with manufacturer's specifications.

Dwell Variation
(Contact Controlled Systems Only)

Dwell variation is determined by noting any dwell change as the engine is operated at different speeds. Excessive variation indicates a change in point opening that can result from shaft or bushing wear, or from the distributor plate shifting because of wear or looseness. In some cases

(Chrysler and Ford) a 5° dwell variation may be normal.

1. Measure distributor dwell at idle speed.

2. Increase speed to 2500 rpm.

3. Note dwell reading at 2500 rpm; then slowly reduce speed to idle while watching Red dwell scale. Dwell reading should not change more than 3 degrees with distributor vacuum lines disconnected and plugged.

Compare with manufacturer's specifications.

Distributor Resistance

Distributor resistance tests are made to determine the primary circuit resistance from the negative terminal of the coil through the distributor to engine ground.

1. Place the AMPERES-DWELL-RPM knob in the DIST RES position.

2. Crank engine until distributor contact points are closed.

3. With the ignition switch on, observe the Red dwell scale.

   The resistance is normal if the pointer stays within the Black DIST RES portion of the scale.

AMPS TEST PROCEDURE

1. Clamp the ammeter probe around one wire of of the circuit to be tested with the arrow on the probe pointing in the direction of expected current flow.

2. Read circuit amperage on appropriate Blue AMPS scale. If the ampere meter pointer goes above the top of the AUTO-TACH/100A scale, change the AMPERES-DWELL-RPM knob to the AUTO-TACH/500A position.

Alternator Output Test

1. Clamp the AMPS PICKUP around the alternator output wire with arrow pointing away from alternator.

2. Set the AMPERES-DWELL-RPM knob to AUTO-TACH/100A.

3. Start engine and run at approximately 1500 rpm.

4. Turn on headlights and all accessories.

5. Observe the Blue AMPS scale for alternator output indication.

   Testing in this manner will usually cause the alternator to charge within specification. However, it is possible that if the accessory load is not great enough, the output seen may not be maximum. If there is any question concerning the condition of the alternator, test with a Volts-Ampere Tester that has an adjustable load.

VOLT-OHM METER

The VOLT-OHM meter is used to measure voltage and resistance. The voltmeter indicates the difference in electrical pressure in volts between any two points in a circuit. The ohmmeter indicates the resistance in ohms between any two points in a circuit.

CRANKING VOLTAGE TEST

1. Connect the VOLT-OHM leads to the battery posts, Red to positive and Black to negative.

2. Turn VOLT-OHM knob to the 20V position for 6 and 12 volt systems and 40V position for 24 volt systems.

3. Disable ignition system by disconnecting the secondary coil wire from the distributor cap or use ENGINE KILL button on tester.

4. Crank engine.

5. Observe cranking voltage, cranking speed and evenness of cranking. Indication should be even and within manufacturer's specifications.

CHARGING VOLTAGE TEST

1. Turn VOLT-OHM knob to the 20V or 40V position depending on the vehicle's voltage.

2. Connect VOLT-OHM leads to the battery posts, Red to positive and Black to negative.

3. With the tachometer connected as previously outlined, operate engine at a speed of 1500 to 2000 rpm.

4. Note voltmeter reading after the meter pointer stops climbing. Indications should be within manufacturer's specification.

IGNITION PRIMARY AND BYPASS CIRCUIT TEST

1. Turn VOLT-OHM knob to 4V position.

2. Connect the VOLT-OHM leads, Red to the positive battery post and Black to the positive side of the ignition coil.

3. Ground the primary terminal of the distributor using a jumper wire.

4. With all lights and accessories turned off, crank engine and observe voltmeter indication. Cranking voltage should be below 0.5 volt or that specified by the manufacturer.

OHMMETER CALIBRATION

The OHMS CAL knob is used to zero the ohm scale on the VOLT-OHM meter when the VOLT-OHM knob is set to the OHM position. When the VOLT-OHM knob is set to either the OHM x 100 or OHM x 1000 positions, the tester automatically sets the pointer to zero.

1. Set VOLT-OHM knob to OHM position.

2. With two ohm leads clamped together, turn OHMS CAL knob to the left or right as necessary until the meter pointer is set at zero.

COIL PRIMARY RESISTANCE TEST

1. Set VOLT-OHM knob to OHM position.

2. Connect VOLT-OHM leads, Red to one coil primary terminal and Black to the other coil primary terminal.

3. Observe Ohmmeter indication and compare with specifications.

COIL SECONDARY RESISTANCE TEST

1. Set VOLT-OHM knob to OHM x 1000 position.

2. Install a Pickup Extension in the tower of coil.

3. Connect VOLT-OHM leads, Red to coil negative or positive primary terminal and Black to the Pickup Extension.

4. Observe Blue ohmmeter scale and compare with coil specifications.

COIL PRIMARY GROUND TEST

1. Connect VOLT-OHM leads, Red to coil negative or positive primary terminal and Black to the coil case.

2. Turn VOLT-OHM knob to OHM x 1000 position.

3. Blue ohmmeter scale should show no pointer movement. Otherwise, a *grounded primary* winding is indicated.

SECONDARY IGNITION CIRCUIT RESISTANCE TEST

1. Place VOLT-OHM knob in the OHM x 1000 position.

2. Connect VOLT-OHM leads, Red to a Test Contactor and Black to an 18-inch jumper wire.

3. Remove distributor cap from the distributor and the spark plug wires from the spark plugs.

4. Connect 18-inch jumper wire (clip) to one of the distributor cap terminals.

5. Connect the Test Contactor to the spark plug end of the wire connected to this distributor cap terminal. Observe Blue ohmmeter scale indication.

6. Repeat Steps 4 and 5 for each spark plug wire and the coil wire. Indications should be as specified by manufacturer.

ALTERNATOR ROTOR CIRCUIT RESISTANCE

1. Place VOLT-OHM knob in the OHM x 100 position.

2. Disconnect alternator field wire from alternator field terminal.

3. Using an appropriate adapter, connect VOLT-OHM leads one to alternator field terminal and the other to alternator or engine ground.

4. Observe Blue ohmmeter scale for field circuit resistance. Indication should be within specifications.

VACUUM GAUGE

The vacuum gauge is used to measure pressure below atmospheric pressure. The scale ranges from 0 to 30 inches. In addition, a scale in millimeters (0-700 mm) is provided for comparison with international car specifications.

CRANKING VACUUM TEST

1. Connect vacuum gauge hose to a source of intake manifold vacuum. Use Tee adapter hoses as required.

2. Disable ignition by disconnecting secondary coil wire from distributor cap or use ENGINE KILL button.

3. Crank the engine and note the action of the vacuum gauge. If the vacuum is very low (less than 1"), it may be necessary to back out the idle speed control or disconnect the electrical throttle stop solenoid in order to increase the cranking vacuum to a higher, more readable level.

4. At the conclusion of the test, restore ignition system operation, and make sure all engine vacuum lines are reconnected properly and securely.

Normal engine condition will result in a steady vacuum that is even and has a rhythmic pulsation.

PCV VALVE TEST

This simple test quickly determines whether or not the PCV system is working properly.

1. Connect the VACUUM gauge lead and disable the ignition system as for the Cranking Vacuum test.

2. While cranking the engine, pinch the PCV hose or close the end of the PCV valve to prevent air from leaking into the intake manifold.

3. Watch the VACUUM gauge.

   An increase in vacuum with the PCV blocked, indicates the PCV system is open and capable of functioning.

4. Enable engine.

NOTE: Also see PCV Test with CO meter.

IDLE VACUUM TEST

Idle vacuum readings aid in determining the existence of any problems relating to compression leaks in the cylinders or intake manifold, leaking or sticky valves, improper timing or fuel mixture which may affect engine operation.

1. Connect VACUUM gauge as for cranking vacuum test.

2. Start engine and operate at specified idle rpm.

A steady vacuum reading between 15" and 22" indicates the engine is in good condition and operating normally.

EXHAUST RESTRICTION TEST

Any unusual restriction in the exhaust system will result in inefficient engine performance at higher than idle speeds. To determine whether restrictions exist, proceed as follows:

1. Connect the VACUUM gauge to the intake manifold in the usual manner.

2. Start engine, operate at idle rpm and note the vacuum reading.

3. Increase engine speed to approximately 2500 rpm and again note the vacuum reading.

An increase in vacuum over the vacuum obtained at idle indicates that the exhaust system is free of restrictions.

FUEL PUMP VACUUM TEST

The fuel pump vacuum test is an auxiliary test and is necessary only when the pump output does not meet the pressure or volume specifications. The fuel pump vacuum test is made to determine whether the defect is in the pump or in the fuel line.

1. Disconnect fuel pump flexible line from tank fuel delivery line.

2. Connect vacuum line from tester to fuel pump using adapter, if necessary.

3. Start engine and operate at idle speed.

4. Run engine for a period of time sufficient to permit VACUUM gauge to reach its maximum reading.

5. Stop engine and observe VACUUM gauge for ten or fifteen seconds.

If maximum vacuum is ten inches or more, and does not fall off when the engine is stopped, the pump valves are OK.

If maximum reading is less than 10 inches, or vacuum falls off rapidly, replace fuel pump.

PPM HC AND % CO METERS

Hydrocarbon (HC) is measured as N-Hexane in parts per million (ppm) and carbon monoxide (CO) is measured in percent (%). Hydrocarbons present in the exhaust system represent unburned gasoline. An increase in the level of HC emission is a direct result of mechanical engine condition, temperature and ignition. Just one spark plug not

firing will raise the HC emission by many times the normal reading in ppm. Carbon monoxide is a by-product of fuel after it is burned in the combustion chamber. An overly-rich mixture will cause a high reading on the CO meter.

Exhaust gas samples are continuously picked up by means of a probe inserted in the vehicle's tail pipe and are conveyed to the exhaust gas analyzer by means of a hose. The infrared analyzing device determines the exact amount of hydrocarbons and carbon monoxide contained in the sample. This data is then converted into electrical signals and read out on the respective meters.

Since governing bodies in several states and metropolitan localities have already set specifications limiting allowable exhaust emissions, the future trends can only be to still further lower the levels of emissions allowed. The infrared exhaust analyzer has been designed and built not only to test present vehicles for compliance with established standards, but also to provide the scale ranges and accuracy necessary to test vehicles for compliance with the anticipated standards of the future.

Besides measuring emission levels to determine compliance with legal standards, you can perform emission tests at several speeds and under various conditions to quickly uncover a variety of engine, ignition and fuel system service requirements. This infrared exhaust analyzer provides the accuracy and range for checking and adjusting carburetors, particularly on late model engines. It also serves as a valuable quality-control tool after tune-up, to aid in determining whether all work was performed properly.

CONNECTION, WARM-UP AND CALIBRATION

1. Mechanically set meters to ZERO line.

2. Depress TEST SELECTOR ZERO button and permit tester to operate for approximately 5 minutes.

3. Depress PPM HC 400 and % CO 2.0 buttons.

4. Depress and hold SPAN mode control button while adjusting SPAN knobs below meters until both meter pointers read SPAN SET.

5. Release SPAN button and recheck ZERO adjustment.

   NOTE: After initial warm-up and calibration, "Zero" and "Span" adjustments can be rechecked at any desired interval, even with the sample probe in the tail pipe of a running engine.

TESTING PROCEDURE

1. Depress the PPM HC 2000 button and the % CO 10 button.

2. Insert sampling probe approximately 12" into vehicle tail pipe.

   a. Be sure that the vehicle's exhaust system is air tight. Air leaking into the system could dilute the exhaust gas and affect the readings.

   b. When testing vehicles with dual exhaust, each side must be tested separately to ensure that an exhaust sample from each bank of cylinders has been analyzed.

3. Depress TEST button of the INFRARED TEST SELECTOR.

4. Operate engine at desired test speed, and note and record readings of both meters. (If HC meter reads less than 400 ppm and/or CO meter reads less than 2.0%, switch to low meter scales for more convenient meter readings by depressing the appropriate scale range button.)

5. If exhaust performance tests are to be conducted at more than one engine speed, readjust engine speed as necessary and repeat Step 4 above.

6. At the conclusion of the tests, depress the ZERO button of the INFRARED TEST SELECTOR.

7. Remove sample probe from the vehicle tail pipe.

   NOTE: Allowing the ZERO button to remain depressed during intervals between tests, the tester will be ready for use without further warmup and filter life will be extended. To turn tester completely off, depress the OFF button.

ENGINE PERFORMANCE TEST

Make tests with engine at normal operating temperature. Refer to manufacturer's specifications and local exhaust emission limits.

NOTE: When testing some electronic fuel injected vehicles without a load, only idle readings will be accurate. Testing of these

engines at 2500 rpm must be done on a dynamometer.

1. Measure HC and CO at 2500 rpm.
2. Measure HC and CO at idle rpm.
3. Compare readings with specifications.

   GOOD: HC and CO readings within specifications at idle and 2500 rpm.

   BAD: HC or CO readings exceed specifications at either idle or at 2500 rpm. Corrective service is required.

NOTE: Always refer to manufacturer's specifications when available. These specifications are usually found on a sticker under the hood. Otherwise, refer to Sun's Specification Cards.

COMMON CAUSES OF EXCESSIVE EMISSIONS

Higher than normal Hydrocarbon readings can be caused by any one or more of the following conditions:

- Improper ignition timing
- Ignition system malfunctions (misfire)
- Excessively rich or lean carburetor
- Engine problems — such as:
  - Low compression
  - Leaky gaskets
  - Defective valves, guides or lifters
  - Defective rings, pistons or cylinders
  - Incorrect thermostat

Higher than normal carbon monoxide readings can be caused by any one or more of the following conditions:

- Rich carburetor
- Dirty air cleaner
- Defective choke
- Improper idle speed

Higher than normal hydrocarbon and carbon monoxide readings can be caused by any one or more of the following conditions:

- Inoperative PCV system
- Heat riser stuck open
- Air pump inoperative or disconnected
- Sticking air cleaner preheat door

To pinpoint specific compression and ignition system deficiencies, conduct detailed tests of these areas. After tune-up, recheck emission levels.

CARBURETOR ADJUST AND TESTING

Adjusting and testing carburetor operation with the infrared Exhaust Performance Tester requires only that you remember how each thing you are changing should affect the air/fuel mixture. If you do something to enrich the air/fuel mixture, the CO level should increase. If you make the air/fuel mixture leaner the CO should decrease. If you make the mixture so lean that one or more cylinders misfire, then the HC level will increase.

Make all carburetor idle and mixture adjustments as per manufacturer's recommended procedure. Where the manufacturer gives a CO setting, use the infrared tester to make these adjustments. On vehicles where CO specifications are not available, use levels below state and local legal limits and normal for the year and make of vehicle being tested. If you are unable to attain the desired HC and LO level by following the manufacturer's adjustment procedures, there may be problems such as faulty ignition or compression. These areas should be thoroughly tested before condemning the carburetor.

IDLE ADJUSTMENT AFTER MAJOR CARBURETOR OVERHAUL OR REPAIR

1. Lightly seat idle mixture adjusting screws.
2. Back out each screw approximately 4 turns or to internal stops if so equipped.
3. Start engine and warm up to normal operating temperatures.
4. Calibrate the infrared tester, insert probe into tailpipe and depress TEST button.
5. Adjust engine idle speed to manufacturer's specifications.
6. Gradually adjust mixture screws equally to obtain the lowest HC reading and smoothest idle.
7. Readjust idle speed as necessary after each mixture adjustment to maintain specified idle rpm.
8. Gradually adjust idle mixture screws equally to obtain lowest CO reading without increasing the HC reading.
9. All readings should be taken with air cleaner

completely installed and at normal operating temperature.

10. HC and CO readings should now be within manufacturer's specification and/or legal limits with engine operating smoothly.

    NOTE: If the idle adjustment process takes longer than two minutes, clean out engine by running it at approximately 2000 rpm for a few seconds.

PCV TEST

Follow this procedure to determine if the PCV system is functioning properly.

1. With engine running, note CO reading on CO meter.

2. Remove PCV valve from the engine but do not remove it from the hose to the carburetor or intake manifold.

3. Observe CO reading on CO meter. CO reading should drop to a lesser value than previously noted.

4. Plug the open end of the PCV valve, and read the CO meter again. The reading should be a greater (richer) value than that taken in Step 3.

   No changes in CO reading indicates the PCV system is not functioning. Clean or replace valve and hoses as necessary and retest.

Accelerator Pump Test

When the throttle is opened rapidly, the accelerator pump sprays fuel into the intake manifold to overcome the lag of fuel flow caused by the resulting momentary drop in manifold vacuum.

Test The Accelerator Pump:

1. While observing the CO meter, with engine at normal idle speed, quickly open and release throttle.

2. The engine should increase speed without hesitation and the CO meter should show an increase in percentage of CO.

3. If the reading decreases more than 0.5% before increasing, or does not increase, the carburetor needs either an accelerator pump linkage adjustment or a repair of the pump mechanism.

AIR PUMP TEST

On vehicles so equipped, an engine-driven air pump supplies fresh air to the exhaust manifold to allow further burning of the exhaust gases before they leave the tailpipe.

Test Effectiveness of System as Follows:

1. Bring engine to normal operating temperature.

2. Calibrate infrared tester and insert sampling probe into tailpipe.

3. Operate engine at approximately 1000 rpm, depress TEST button and note HC and CO readings.

4. Maintaining the same engine speed, disconnect the air supply hose leading from the air pump to the exhaust manifold and again note HC and CO readings.

   An increase in HC and CO readings is to be expected with hose disconnected if the air supply system is operating normally. If little or no increase in HC and CO readings are observed, examine all components in the air supply system and make repairs and corrections necessary.

5. Upon completion of the tests, reconnect air supply hose and reset engine idle speed to manufacturer's specifications as necessary.

TIMING ADVANCE UNIT

The Timing Advance Unit is a power timing light equipped with a rotating indicator to measure the amount of advance of the spark due to the action of the mechanical and vacuum advance mechanism or electronic control devices. This unit is used to test or set the initial timing and to quickly test the action of the advance devices.

INITIAL TIMING

1. Connect trigger pickup to the timing cylinder, usually No. 1.

2. Place the CYCLE selector to the proper position, 4 CYCLE or 2 CYCLE.

3. Set AMPERES-DWELL-RPM knob to AUTO-TACH/DWELL.

4. Start and run the engine until it reaches operating temperature.

5. Set the engine rpm to the speed specified for initial timing.

6. Remove or disconnect vacuum hoses if speci-

fied. Plug vacuum source to prevent rpm change.

7. Set Timing Light Switch to ON, and aim timing light at engine timing marks.

8. Adjust rotating control on the back of timing light assembly until the timing mark on the rotating pulley aligns with the zero mark on the engine timing scale.

   Initial timing should be within 1 degree of specification.

9. Replace vacuum line(s) if removed.

TIMING ADVANCE

1. Adjust engine rpm to the next desired test point.

2. Readjust the rotating control on the back of the light until the timing mark is again aligned with the zero mark on the timing scale.

3. Record timing advance indicated.

   NOTE: Reading will not include vacuum advance on vehicles equipped with a Transmission Controlled Spark (TCS) system. On most TCS systems, full vacuum advance at the distributor is not attained unless the transmission is in high gear.

4. Repeat Steps 1, 2 and 3 at each desired check point.

   Timing advance should be within specifications.

   NOTE: If desired, the operation of only the mechanical advance can be tested in the same manner as outlined above except that the vacuum line is not reconnected at the end of the initial timing test.

MAINTENANCE AND SERVICE

OPERATOR SERVICE INSTRUCTIONS

The service and maintenance procedures presented in this section are those which the operator can perform himself. All other service should be performed by the local Sun representative. The computer will indicate on the SELF TEST page when trouble exists in the tester.

SERVICE PROCEDURE

The SUN 1115 is a precision diagnostic and service instrument. With reasonable care, it will prove many years of reliable service. The maintenance and service procedures presented herein do not require any special skills to perform. However, they do require care and attention to avoid any accidental damage to the equipment/

Maintaining Tester Finish

The SUN 1115 has a finish of Acid and Stain resistant baked enamel and chromium plating. You can keep your tester bright and new looking by protecting its enameled and plated surfaces with a good quality automobile polish or wax. Once it has been protected with a coat of polish, it will only require a periodic wipe down with a damp cloth followed by a wipe down with a dry cloth.

Lubrication

All pumps, motors, etc. contained in the tester cabinetry are equipped with sealed bearings and require no periodic lubrication. A few drops of light machine oil every sixty to ninety days applied to the pivots and axles of the cabinet casters will keep them rolling free.

Plastic Mesh Filter Service

Fitted behind a window at left end of the tester headframe assembly is a plastic mesh filter. This filter is used to clean the air which is drawn into the headframe for cooling purposes. The filter should be removed every sixty to ninety days for cleaning. More frequent cleaning is desirable if extremely dusty conditions prevail. The filter should be

Test Lead Maintenance

The test leads and power cord are made of the finest materials available for their purpose. As with any flexible cable or hose reasonable care should be taken so as not to subject them to undue strain, high temperature or unnecessary abuse. They will retain their new appearance if they are cleaned periodically with waterless hand cleaner and wiped dry.

PROBE MAINTENANCE

Visually inspect probe tip daily for damage. Examine holes in probe tip to insure they are not clogged. If holes are clogged, use a paper clip or stiff wire to clear holes of dirt or foreign matter. Check tightness of fitting connection to base assembly.

SAMPLING HOSE MAINTENANCE

Visually inspect sampling hose assembly daily for leaks, cuts, kinks or damage caused by vehicles accidentally running over it. Check fitting connections for tightness and leaks.

FILTERS

Packaged with the exhaust emission testers are extra exhaust filter elements which are to be used as necessary.

Replacement Parts
For Field Service

Description	Part No.
Exhaust Probe Assembly	7009-511
Slide Bracket Assembly	7020-1043
Handle	813-101
Flex Tube Assembly	7020-1094
Hose Assembly	3988-202
Primary Filter Assembly	301-115
Filter Element (75 micron)	301-926
"0" Ring Seal	617-199
Secondary Filter Assembly	301-116
Filter Element (8 micron)	301-908
"0" Ring Seal	617-199

OPTIONAL ACCESSORIES

VW Exhaust Probe for Catalytic Equipped Models 120-239

Chrysler Exhaust Probe For Catalytic Equipped Models 120-236

Replacement parts or service may be obtained by contacting your local Sun representative or your nearest Sun branch.

WHEN TO SERVICE

The exhaust sample handling system should be cleaned and serviced when the Yellow LOW-FLOW indicator under the HC meter on the tester panel lights. If the LOW-FLOW indicator does not stop glowing when the exhaust probe is serviced, the filters will have to be cleaned or replaced.

NOTE: The SUN 1115 and 1115-9 filter assemblies are serviced in the same manner, but are arranged differently on the tester. See Figure 32 for the 1115, or Figure 33 for the 1115-9 filter arrangement.

PRIMARY FILTER SERVICE

(Element should be cleaned or replaced as necessary.)

NOTE: Observe Filter from bottom.

1. Remove outlet and inlet hoses from "T" fitting on lower part of bowl
2. Unscrew filter bowl from housing by turning ring nut counterclockwise. Note position of "0" ring seal on filter housing and filter housing shaft. See Figure 32 for the 1115 and Figure 33 for the 1115-9.
3. Turn element retainer counterclockwise and remove filter element.
4. Clean bowl and element in a solution of detergent and water and air dry. If element replacement is necessary, use Sun No. 301-926 filter element.
5. Assemble in reverse order making sure "0" ring is properly positioned in groove at upper edge of bowl. Reconnect inlet hose to side of "T" fitting that has the smallest opening.

SECONDARY FILTER SERVICE

(Element should be replaced as necessary.)

NOTE: Observe Filter from bottom.

1. Remove filter bowl from housing by turning ring nut counterclockwise and remove bowl. See Figure 32 for the 1115 and Figure 33 for the 1115-9.
2. Inspect "0" rings on filter housing shaft and filter housing.
3. Turn element retainer counterclockwise and remove filter element.
4. Remove filter element and replace with Sun No. 301-908 element. (Do not attempt to clean.)
5. Wash filter bowl in a solution of detergent and water and air dry.
6. Assemble in reverse order making sure all "0" rings are properly positioned and drain cock is fully closed.

Sun 1115 Filter Arrangement

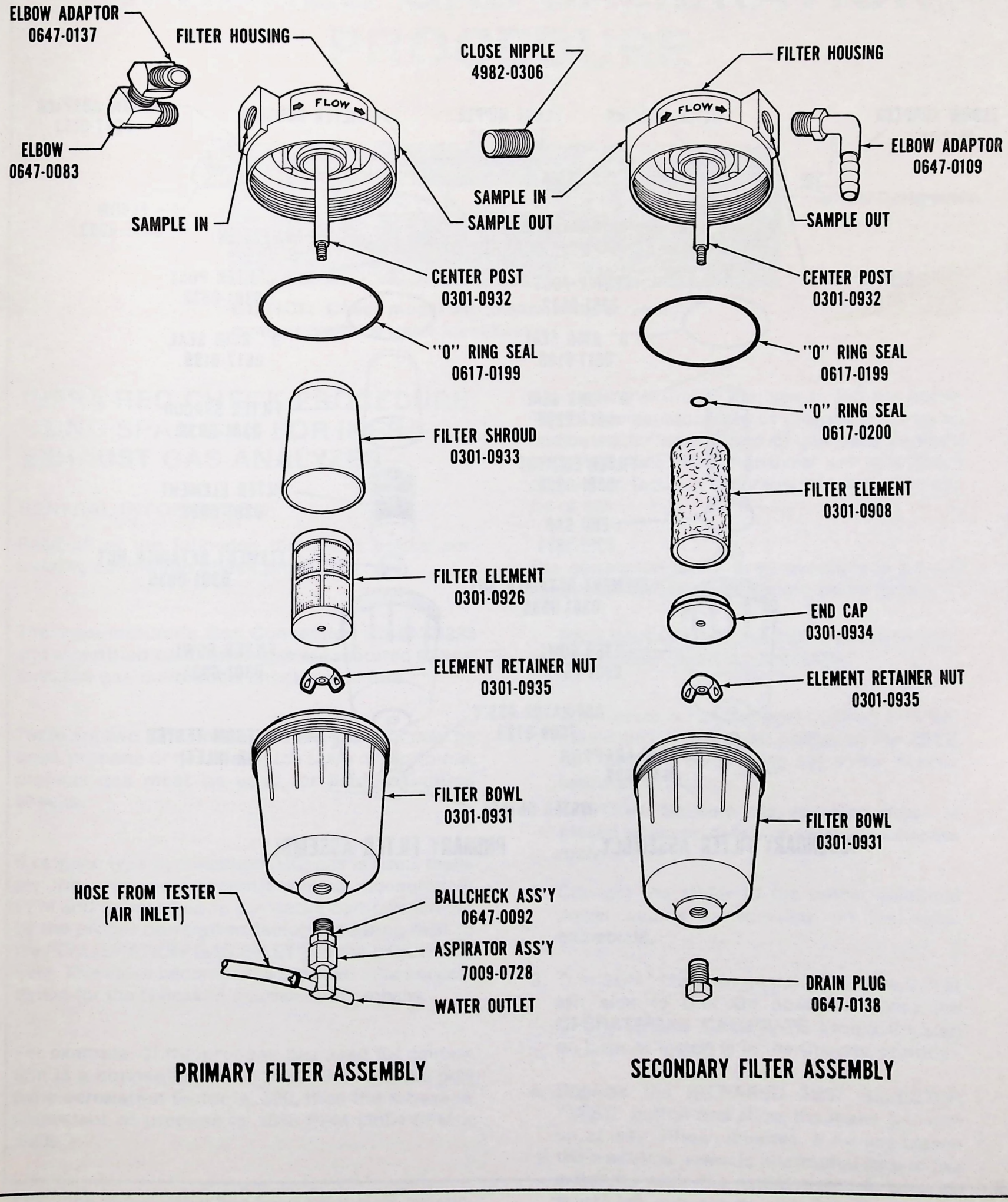


FIGURE 32—Sun 1115 Filter Assemblies.

Sun 1115-9 Filter Arrangement

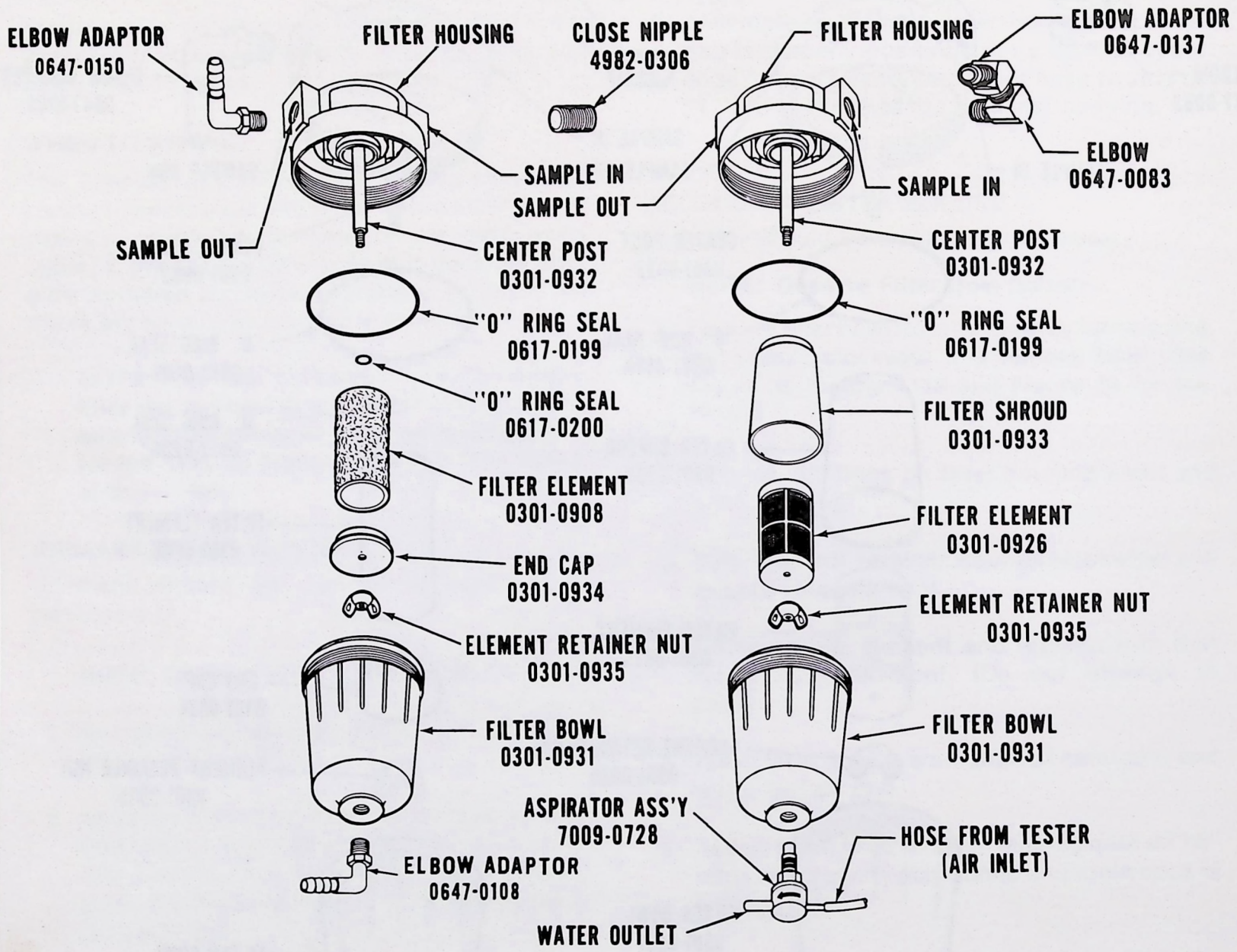
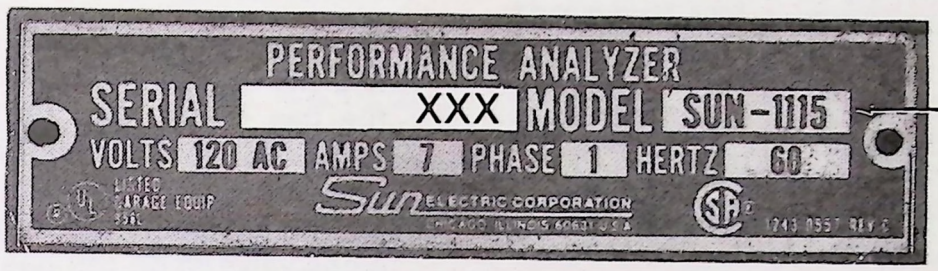


FIGURE 33—Sun 1115-9 Filter Assemblies.

SUN 1115
INFRARED GAS CALIBRATION PROCEDURE



Model Designation

NOTICE: Check model designation listed on serial number plate for tester identification.

INFRA-RED CHECK PROCEDURE USING SPAN GAS FOR INFRA-RED EXHAUST GAS ANALYZER

GENERAL INFORMATION

Read all of the following directions before performing calibration check procedure.

The manufacturer's Gas Connection Kit #120-223 and a certified calibration gas are required to perform the gas calibration check procedure.

There are two kinds of calibration gas that may be used, propane or hexane. In the state of California, propane gas must be used for field calibration checks.

If propane type hydrocarbon (HC) gas is used, multiply the propane concentration as measured in PPM and denoted upon the bottle certification tag by the proper correlation factor appearing next to the "CALIBRATION GAS INLET" on the HC/CO analyzer. This value becomes the adjusted PPM concentration for the N-hexane equivalent of propane.

For example: If the propane gas used for calibration is a concentration of 3054 PPM and the propane correlation factor is .520, then the N-hexane equivalent of propane is 1588 PPM (3054 PPM x .520).

Once the above value has been computed, we suggest that you record it upon a piece of white adhesive tape and affix the tape to the gas bottle. The N-hexane equivalent of propane must be recomputed for each bottle of gas used and/or if more than one HC/CO analyzer with a different correlation factor is calibrated with the same bottle of gas.

The correlation factor does not apply to the CO concentration stated on the gas bottle label.

PRELIMINARY MECHANICAL/ELECTRICAL ZERO AND SPAN ADJUSTMENT

1. With tester off a minimum of three minutes, mechanically zero each pointer to the ZERO SET LINE by turning the set screw directly below each meter.

   CAUTION: Be sure the sampling probe is placed where no debris or water will enter the probe.

2. Connect the tester to the proper electrical power source as specified on the serial nameplate.

3. Turn SUN 1115 on by pushing power switch at left side to Unit On position. Insure the OPERATE/GAS CALIBRATE switch (located on back of tester) is in the Operate position.

4. Depress the INFRARED TEST SELECTOR "TEST" button and allow the tester to warm up at least fifteen minutes. If for any reason the electrical power is interrupted (one to five seconds) after the initial warmup, an additional ten minutes must be allowed for the unit to re-stabilize.

5. After warmup, depress the INFRARED TEST SELECTOR "ZERO" button.

6. Depress the PPM HC AND % CO low scale buttons designated "400" and "2.0" under the two infrared meters.

7. "Zero Set" meters in low range scale by turning the ZERO adjusting control knob for each meter until the pointer is on the ZERO SET LINE.

8. Depress and hold the INFRARED TEST SELECTOR "SPAN" button, (LOW FLOW LIGHT should light to check bulb operation).

   Adjust each SPAN control knob for each meter until the pointer is on the SPAN SET LINE.

9. Release SPAN button: Meters should indicate zero. If meters do not return to within one pointer width of the ZERO SET LINE, repeat steps 5 through 9.

10. Depress the high scale PPM HC and % CO button on each of the two meters designated "2000" and "10". Meters should indicate zero. If meters do not read within one pointer width of the ZERO SET LINE, repeat steps 5 through 9.

LOW AND HIGH SCALE COMPARISON CHECK

11. Depress the PPM HC low scale button designated "400" and turn the ZERO control until the HC meter indicates 340 PPM on low scale.

12. Depress the PPM HC high scale button. Pointer should indicate 340 PPM on high scale within ± ½ division.

13. Depress the HC low scale button (400) and turn the ZERO control of the HC meter until the pointer is on the ZERO SET LINE.

14. Depress the CO low scale button designated "2.0" and turn the ZERO control until the CO meter indicates 1.4% on low scale.

15. Depress % CO high scale button designated "10". Pointer should indicate 1.4% on high scale within ± ½ division.

16. Push the CO low scale button (2.0) and turn the ZERO control of the CO meter until the pointer is on the ZERO SET LINE.

17. Return the HC and CO buttons to the high scale positions.

18. Connect the hose from the gas bottle to the Calibration Gas inlet located on the side of the tester above the secondary filter (on older 1115 models) and below the filters (on newer 1115 models). Refer to Recommended Hook-up Procedure.

19. Set the toggle switch on rear of tester to GAS CALIBRATE position.

20. Slowly open the low pressure tank main valve and the gas regulator valve (if applicable) on the gas bottle until the in-line balloon just begins to inflate (do not expand), indicating a flow of gas into the tester. After meter readings stabilize (about 10 to 15 seconds) close valve(s) on the gas bottle.

21. Read HC meter in the 0-2000 scale. If the PPM reading of HC is within ± 60 PPM of the N-hexane equivalent concentration, the HC section is within acceptable limits.

    For example: If the HC gas sample has a concentration of 1588 PPM, the meter may indicate ± 60 PPM, or from 1528 to 1648 and be within specified tolerance limits.

22. Read CO meter on the 0-10 scale. If the % CO meter reading is within ± .3% of the certified % CO sample, the CO section is within acceptable limits.

    For example: If certified CO gas sample is 7.56%, the meter may indicate ± .3%, or from 7.26% to 7.86% CO and be within specified tolerance limits.

23. Disconnect hose from gas inlet.

24. Insure that INFRARED TEST SELECTOR "ZERO" button is depressed, and set toggle switch on rear of tester to OPERATE position to expel gas from sample cell.

    If test results are not within allowable tolerances, or service is required, refer to calibration procedure below, or contact your local Sun representative.

GAS CALIBRATION PROCEDURE

Although your SUN 1115 has been factory adjusted and calibrated to assure optimum accuracy, the California Bureau of Automotive Repair requires the owner be given the opportunity to gas calibrate the infrared portion of the unit.

In keeping with the requirements of the law, the manufacturer provides the following calibration procedure:

1. With tester off a minimum of three minutes, mechanically zero each pointer to the ZERO SET line by turning the set screw directly below each meter.

   CAUTION: Be sure the sampling probe is placed where no debris or water will enter the probe.

2. Connect the tester to the proper electrical power source as specified on the serial nameplate.

3. Turn SUN 1115 on by pushing power switch at left side to Unit On position. Insure the OPERATE/GAS CALIBRATE switch (located on back of tester) is in the OPERATE position.

4. Depress the INFRARED TEST SELECTOR "TEST" button and allow the tester to warm up at least fifteen minutes. If for any reason the electrical power is interrupted (one to five seconds) after the initial warmup, an additional ten minutes must be allowed for the unit to re-stabilize.

5. After warmup, depress the INFRARED TEST SELECTOR "ZERO" button.

6. On the front of the tester, remove the aluminum molding strip by loosening the retaining screws, and swing the control panel away from the tester to allow access to the calibration boards located on the right side of the control panel.

7. After the unit has warmed up, depress the HC and CO Low Range buttons. Set the meter pointers to 2.0% CO and 400 PPM HC by adjusting the zero control knobs.

8. Switch both meters to the high scale range.

9. Using the calibration tool, P/N 0001-0021, which is provided in the Gas Calibration Kit, P/N 120-223, insert the tool into the adjusting slot of calibration pot R10 (CO HIGH RANGE ADJ.) Adjust R10 to 2% CO on the meter face. Using the same procedure, adjust R9 (HC RANGE ADJ.) to 400 PPM HC on the meter face.

10. Change meters to low scale range.

11. Zero the meter pointers by adjusting the front panel Zero control knobs.

12. Return the HC and CO buttons to the high scale positions.

13. Connect the hose from the gas bottle to the Calibration Gas inlet located on the side of the tester above the secondary filter (on older 1115 models) and below the filters (on newer 1115 models). Refer to Recommended Hook-up Procedure.

14. Set the toggle switch on rear of tester to GAS CALIBRATE position.

15. Slowly open the low pressure tank main valve and the gas regulator valve (if applicable) on the gas bottle until the in-line balloon just begins to inflate (do not expand), indicating a flow of gas into the tester. After meter readings stabilize (about 10 to 15 seconds), close valve(s) on the gas bottle.

16. Adjust the front panel Span Control knobs until the meter pointers indicate the known gas concentration values. Disconnect hose from gas inlet. Insure that INFRARED TEST SELECTOR "ZERO" button is depressed, and set toggle switch on rear of tester to OPERATE position.

17. Insert the calibration tool into the adjusting slot of calibration pot R6 (CO SPAN ADJ.). Depress the "SPAN" button on the front panel and adjust R6 until the meter pointer is at the SPAN SET LINE on the CO meter. Using the same procedure, adjust R5 (HC SPAN ADJ.) until the meter pointer is at the SPAN SET LINE on the HC meter.

18. Insure that the HC and CO buttons are in the high scale positions and meter readings return to zero.

CALIBRATION CHECK PROCEDURE

19. Connect the hose from the gas bottle to the Calibration Gas inlet located on the side of the tester above the secondary filter (on older 1115 models) and below the filters (on newer 1115 models). Refer to Recommended Hook-up Procedure (Figure 34).

20. Set the toggle switch on rear of tester to GAS CALIBRATE position.

21. Slowly open the low pressure tank main valve and the gas regulator valve (if applicable) on the gas bottle until the in-line balloon just

begins to inflate (do not expand), indicating a flow of gas into the tester. After meter readings stabilize (about 10 to 15 seconds), close valve(s) on the gas bottle.

22. Read HC meter on the 0-2000 scale. If the PPM reading of HC is within ± 60 PPM of the N-hexane equivalent concentration, the HC section is within acceptable limits.

    For example, if the HC gas sample has a concentration of 1588 PPM, the meter may indicate ± 60 PPM or from 1528 to 1648 and be within specified tolerance limits.

23. Read CO meter on the 0-10 scale. If the % CO meter reading is within ± .3% of the certified % CO sample, the CO section is within acceptable limits.

    For example, if the CO gas sample has a concentration of 8.16%, the meter may indicate ± .3% or from 7.86% to 8.46% and be within specified acceptance limits.

24. Disconnect hose from gas inlet.

25. Insure that INFRARED TEST SELECTOR "ZERO" button is depressed, and set toggle switch on rear of tester to OPERATE position.

26. Replace the control panel and the aluminum molding strip to the original position and tighten the retaining screws.

NOTE: If any error is indicated, repeat calibration procedure or contact your local Sun Representative for service.

LOW PRESSURE HOOKUP—Use Figure 34 as a guide.

1. Place threaded end of flare nut No. 647-5904 over non-flared end of Flow Restrictor Assembly No. 7009-0875.

2. Fit 5-foot hose No. 669-229 over non-flared end of Flow Restrictor Assembly.

3. Fit tee No. 7009-0853 into other end of the 5-foot hose.

4. Fit 5-inch hose No. 669-229 over the other end of tee.

5. Fit balloon over remaining tee port and secure with rubber band.

6. Attach kit to tank with flare nut No. 647-5904.

7. Attach kit to tester by fitting 5-inch hose over calibration gas inlet port.

8. Follow instructions under calibration check procedure for calibration gas check.

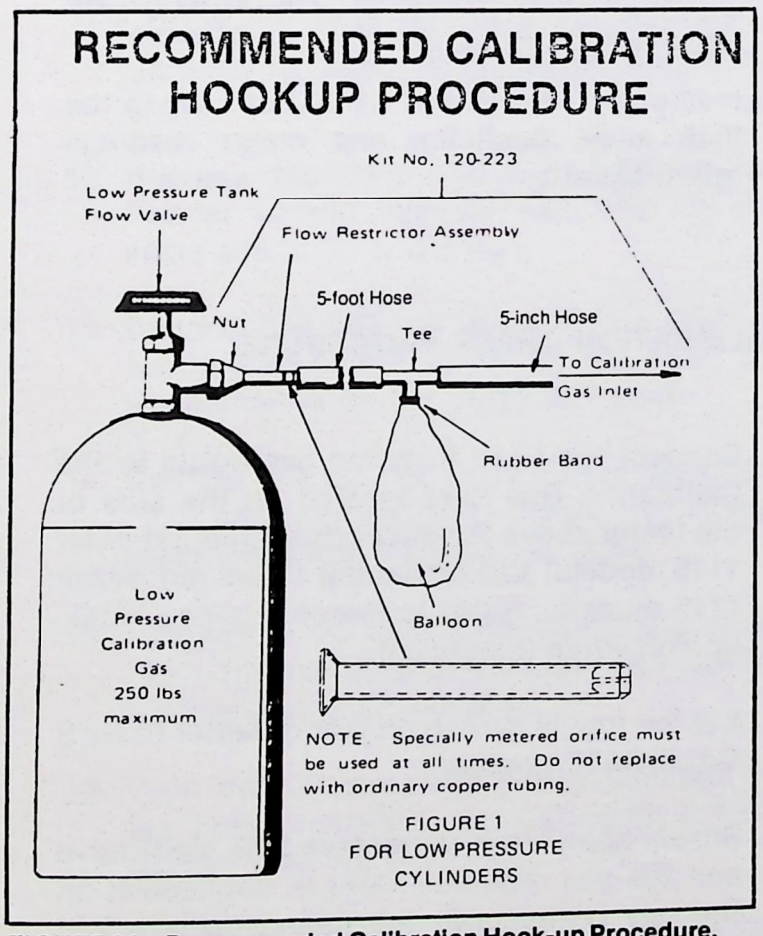


FIGURE 34—Recommended Calibration Hook-up Procedure.

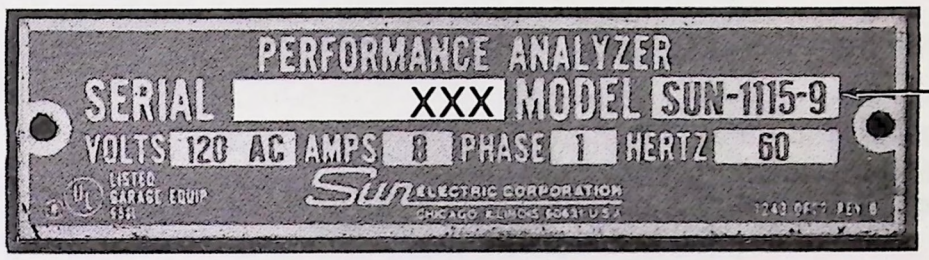
PARTS LIST FOR GAS CONNECTION
KIT NO. 120-223

PART DESCRIPTION	PART NUMBER
Plastic hose 5 in. x 3/16-in. I.D.	669-229
Plastic hose 5 ft. x 3/16-in. I.D.	669-229
Manifold—Balloon Assembly	7009-0853
Flow Restrictor Assembly	7009-0875
Nut, 1/4-in., S.A.E. flare	647-5904
Calibration Tool	0001-0021

Available from Manufacturer.

SUN 1115-9

INFRARED OPERATING AND GAS CALIBRATION PROCEDURE


PERFORMANCE ANALYZER
SERIAL XXX MODEL SUN-1115-9
VOLTS 120 AC AMPS 8 PHASE 1 HERTZ 60
LISTED GARAGE EQUIP
Sun ELECTRIC CORPORATION
CHICAGO ILLINOIS U.S.A.

Model Designation

NOTICE: Check model designation listed on serial number plate for tester identification.

PREPARATION

1. If necessary, zero HC and CO meters by turning zero adjust screws on meters (machine must be turned off before these adjustments are made).

2. Connect ac line cord to 120V, 60 Hz outlet.

3. Turn AC POWER SWITCH to UNIT ON position.

4. Depress the INFRARED TEST SELECTOR "ZERO" button.

5. When unit is ready for use, the READY light will come on.

ZERO/SPAN SET

1. Set PUMP switch (back of tester) to OPERATE position.

2. Set I.R. CAL AND LEAK TEST switch (Figure 35, 1) to the OFF position.

3. Depress the 400 PPM HC and 2.0% CO buttons. Corresponding range lights will go on.

4. Use the HC ZERO and CO ZERO knobs to adjust meters to the ZERO SET LINE.

5. Depress and hold the INFRARED TEST SELECTOR "SPAN" button while using HC SPAN and CO SPAN knobs to set SPAN SET LINE.

6. Release SPAN button. Meter will return to 0 (if not, repeat steps 4 through 6).

ENGINE EXHAUST TESTING

PREPARATION

1. Depress INFRARED TEST SELECTOR "TEST" button.

2. Set pump switch (back of tester) to OPERATE position.

   NOTE: When the pump switch is in the GAS CALIBRATE position, the LOW FLOW LIGHT will be lit. If the LOW FLOW LIGHT is lit in the OPERATE position, there is a line restriction. Check filters and sample hose (Figure 35, 5 and 35, 6).

TESTING

1. Depress the HI scale range buttons for both HC (2000 PPM) and CO (10%).

2. Insert sampling probe approximately 12″ into vehicle tailpipe.

   a. Be sure that the vehicle's exhaust system is air tight. Air leaking into the system could dilute the exhaust gas and affect the readings.

   b. When testing vehicles with dual exhaust, each side must be tested separately to ensure that an exhaust sample from each bank of cylinders has been analyzed.

3. Operate engine at desired test speed, and note and record readings of both meters. (If HC meter reads less than 400 PPM and/or CO meter reads less than 2.0%, switch to lower meter scales for more convenient meter read-

ings by depressing the appropriate scale range pushbuttons).

4. If exhaust performance tests are to be conducted at more than one engine speed, readjust engine speed as necessary and repeat step 3 above.

5. At the conclusion of the tests, depress the ZERO mode control pushbutton.

6. Remove sample probe from vehicle tailpipe.

NOTE: Allowing the mode control switch to remain in the ZERO position during intervals between tests, the tester will be ready for use without further warm up and filter life will be extended.

LEAKAGE TEST CALIBRATION

1. Depress the INFRARED TEST SELECTOR "ZERO" button.

2. Set the OPERATE/CAL switch (on back of tester) to the GAS CAL position.

3. Turn the I.R. CAL/LEAK switch to the LEAK position (Figure 35, 1).

4. Plug the sampling probe tip.

5. Turn the I.R. CAL/LEAK switch to the HOLD POSITION. At the same time, switch the OPERATE/CAL switch to OPERATE.

NOTE: As soon as the VACUUM LIGHT comes on, the I.R. CAL/LEAK switch must be released and the OPERATE/CAL switch returned to the GAS CAL position for a valid test.

a. If the VACUUM LIGHT does not come on, the leakage is too excessive. At this point, all leakage testing should be stopped, and the leaks repaired.

b. If the VACUUM LIGHT turns off with the FAIL LIGHT off, the leakage is acceptable.

c. If the FAIL LIGHT comes on before the VACUUM LIGHT turns off, the leakage is NOT acceptable. Stop all leakage testing and repair the leaks.

INFRARED CALIBRATION INTERNAL MODE

1. Repeat ZERO/SPAN SET procedure.

2. Push the 2000 PPM HC and 10% CO buttons.

3. Open gas bottle by rotating valve counterclockwise.

NOTE: It is recommended that gas bottle be replaced if bottle pressure drops below 30 psi.

4. Set I.R. CAL AND LEAK TEST switch to INT. position (Figure 35, 1).

5. Push GAS FLOW button (Figure 35, 2). Gas will automatically flow for a predetermined amount of time.

6. Use HC SPAN and CO SPAN knobs to set HC and CO meters to read tag value of calibration gas.

7. Set I.R. CAL AND LEAK TEST switch to OFF position. Meters will return to ZERO SET LINE.

8. Depress and hold SPAN button, while adjusting the HC and CO CAL controls (located in the filter pocket) until both meters read at SPAN SET LINE.

9. After calibration is complete, close calibration gas bottle by rotating valve clockwise.

INFRARED CALIBRATION EXTERNAL MODE

1. Repeat ZERO/SPAN SET procedure.

2. Depress the 2000 PPM HC and 10% CO buttons.

3. Connect calibration gas to CAL GAS INLET port in filter pocket (Figure 35, 7).

4. Open valve on calibration gas by turning valve counterclockwise.

5. Set I.R. CAL AND LEAK TEST switch to EXT. position.

6 . Set Pressure Regulator to 5 psi.

7. Use HC SPAN and CO SPAN knobs to set HC and CO meters to tag value of calibration gas bottle.

8. Set I.R. GAS AND LEAK TEST switch to OFF position.

9. Close valve on gas bottle. Meters will return to ZERO SET LINE.

10. Depress and hold SPAN button, while adjusting the HC and CO CAL controls (located in the filter pocket) until both meters read at SPAN SET LINE.

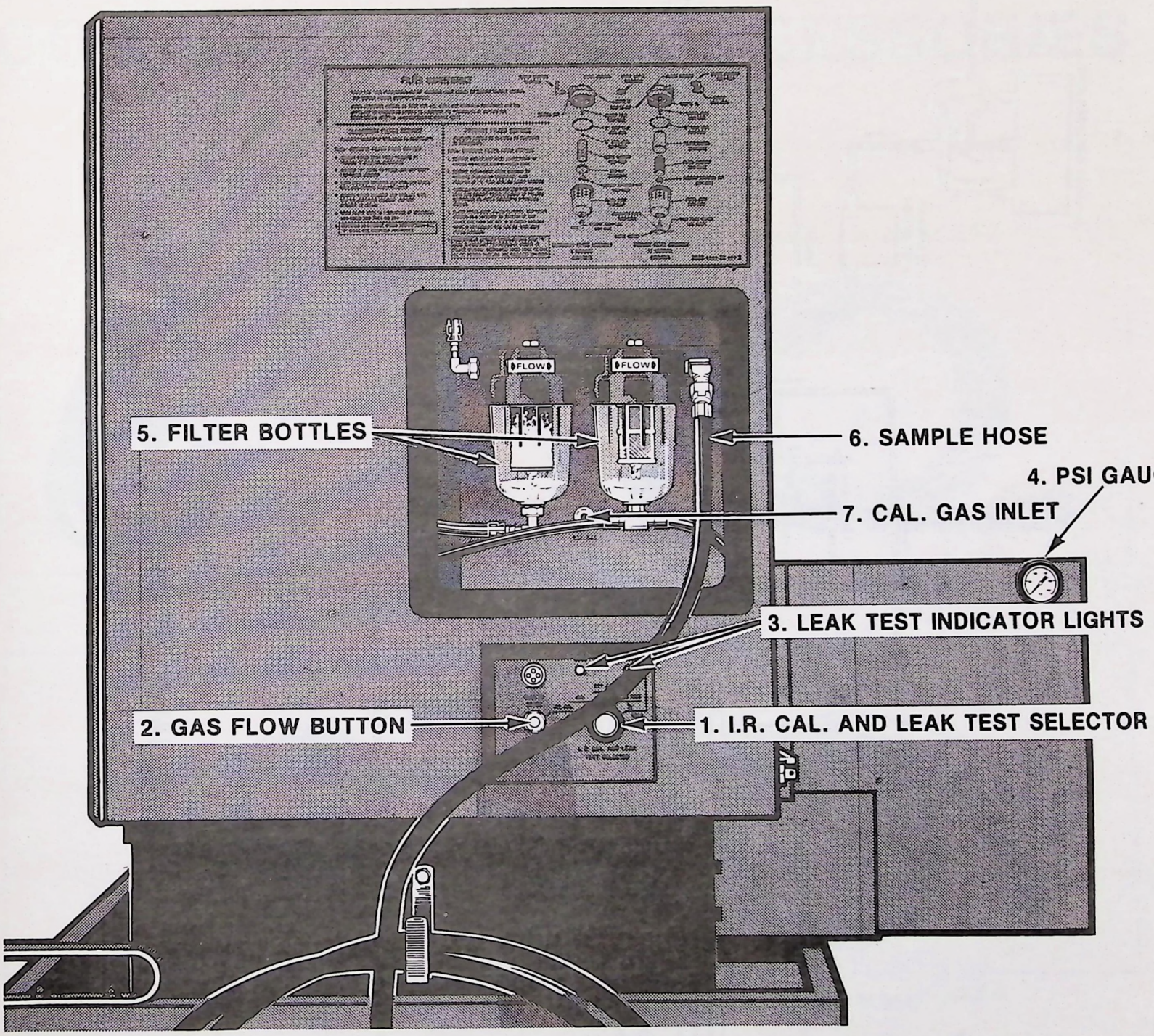
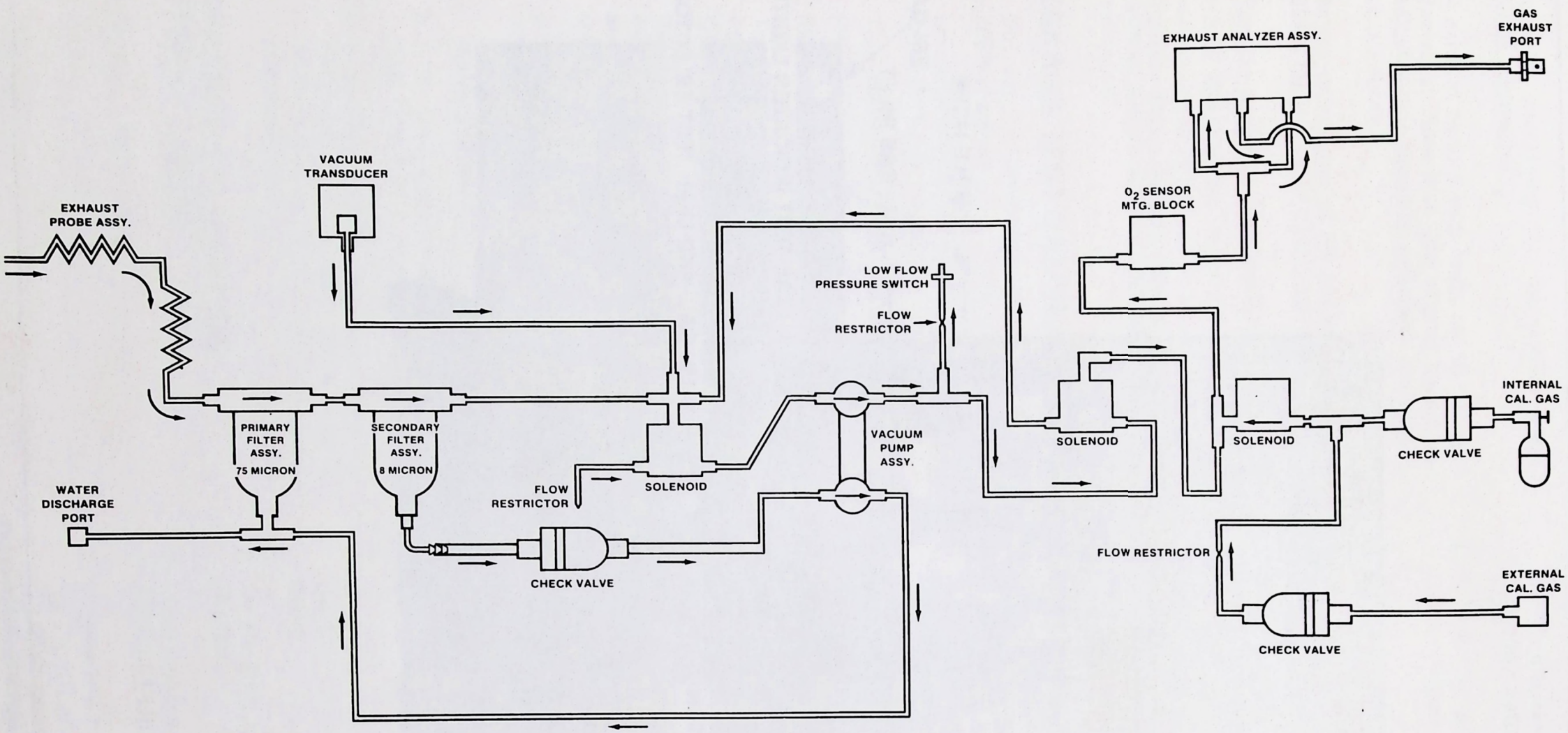
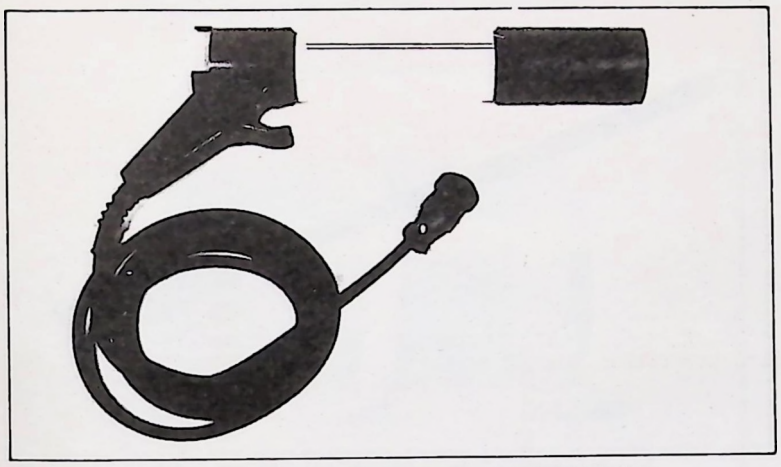


FIGURE 35—Side Panel for Infrared Operating and Calibration Procedure.

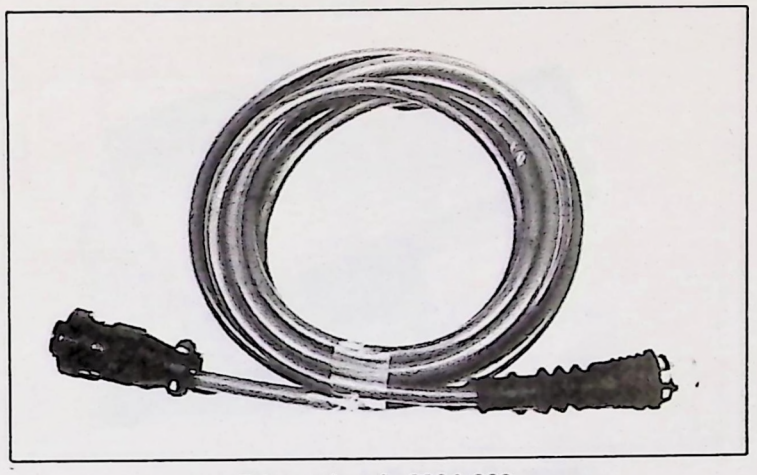


PNEUMATIC DIAGRAM
FOR SUN 1115-9

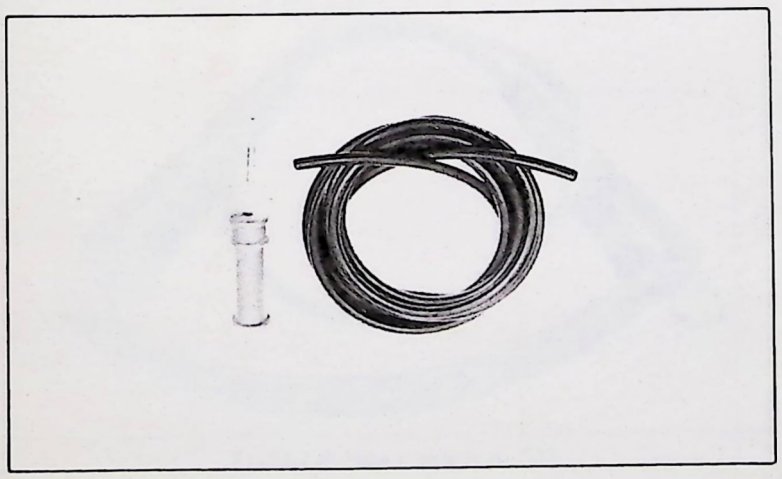
COMPONENTS AND ACCESSORIES



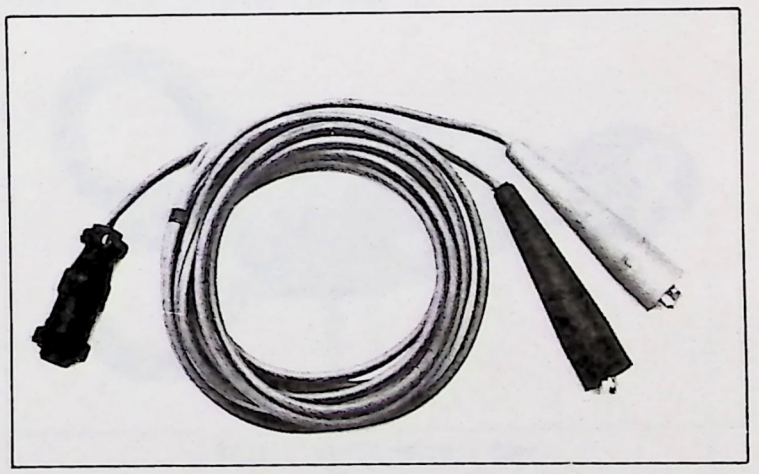
Timing Advance Unit 7010-463 [TAU-120]



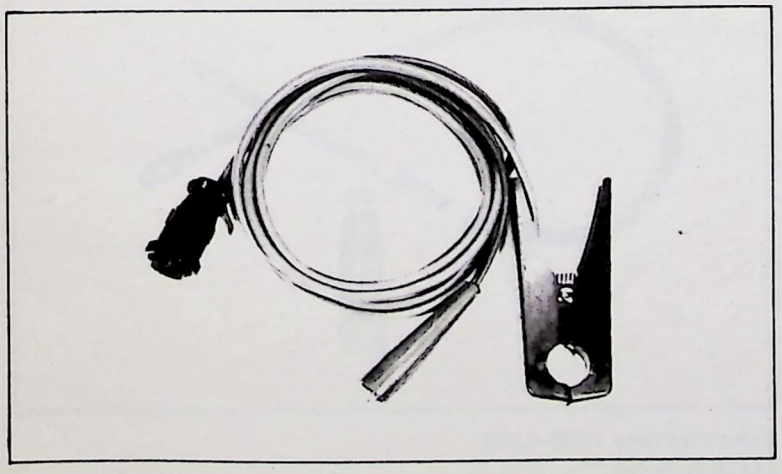
Trigger Lead 6004-262



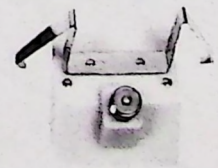
Vacuum Hose Assembly 6006-003



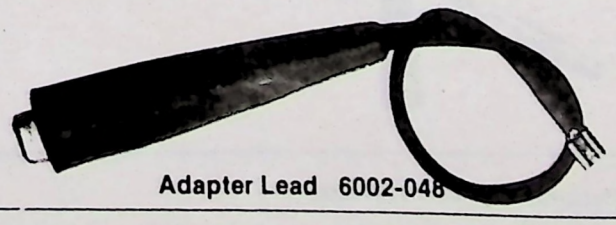
Volt-Ohmmeter Lead 6004-249



Ammeter Lead Assembly 6005-139



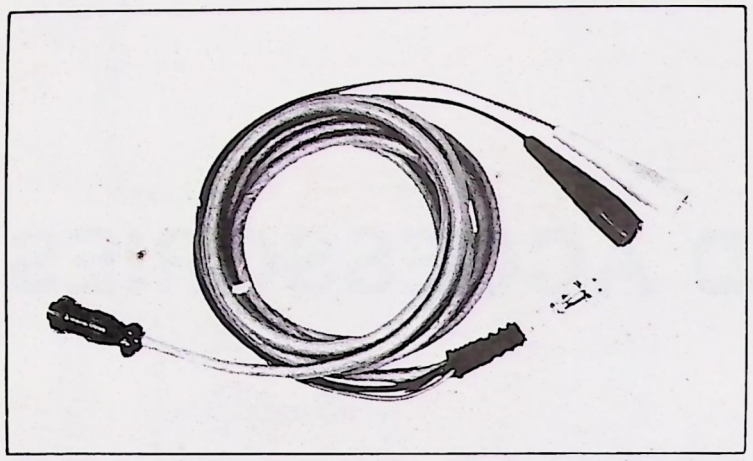
HEI Adapter 1747-102



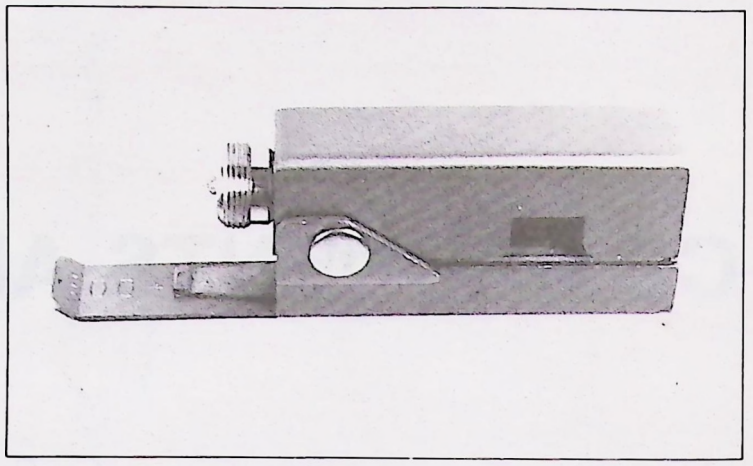
Adapter Lead 6002-048

HEI Adapter Kit 0120-0240

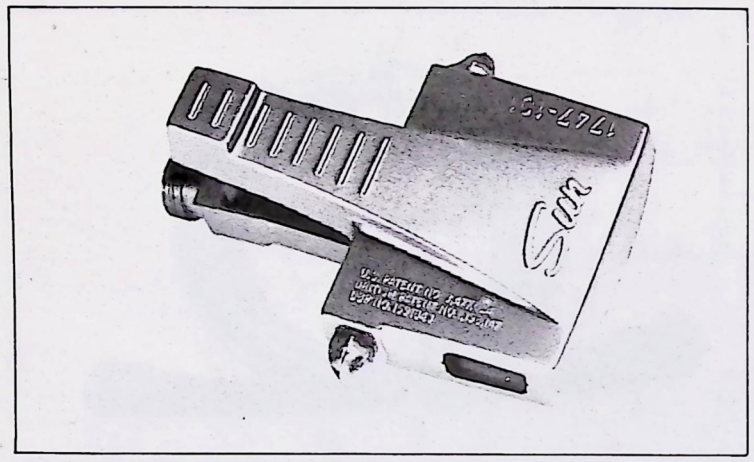
Components and Accessories



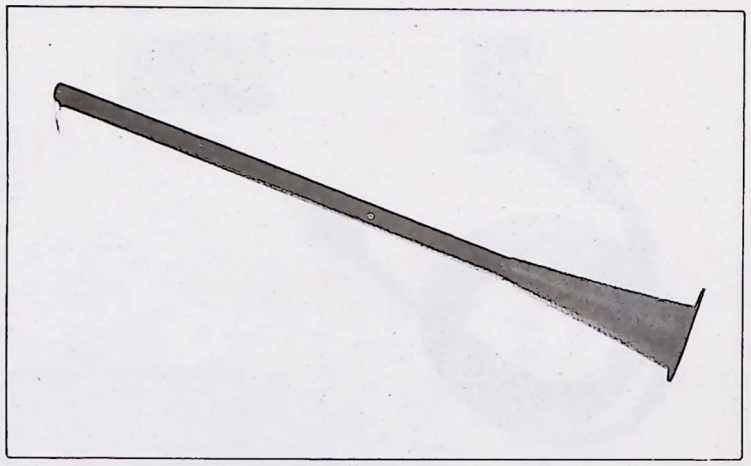
Pattern Pick-Up Lead 6005-132



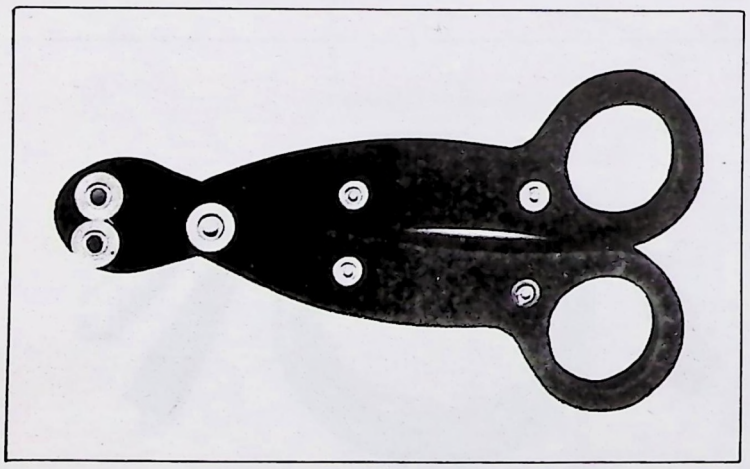
Trigger Pickup 507-6



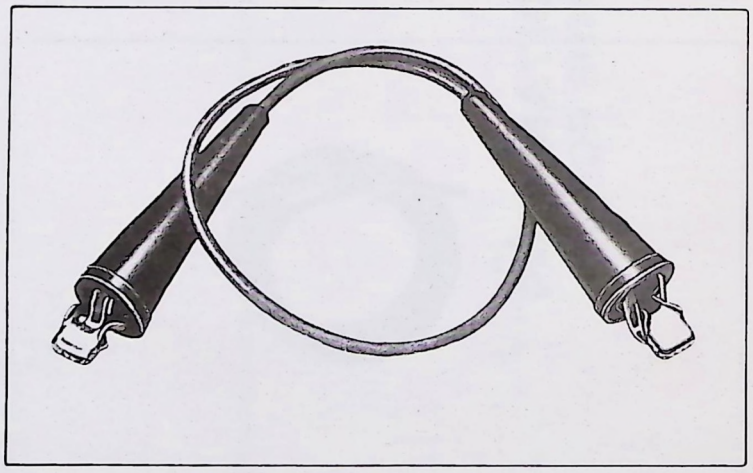
Chrome Pattern Pick-Up 1747-101



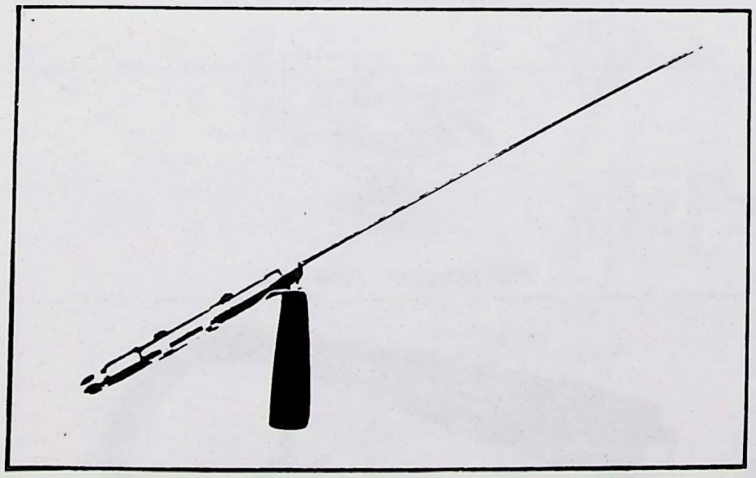
Resistance Test Contactor 4344



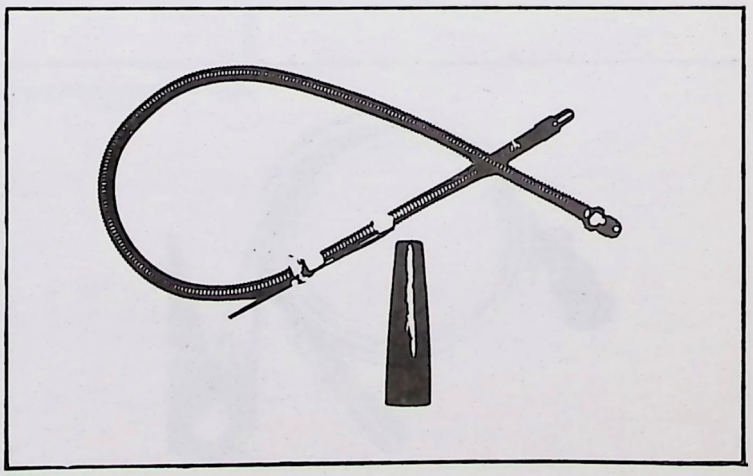
High Tension Pliers 2-1028



18" Jumper Lead 2-133-15

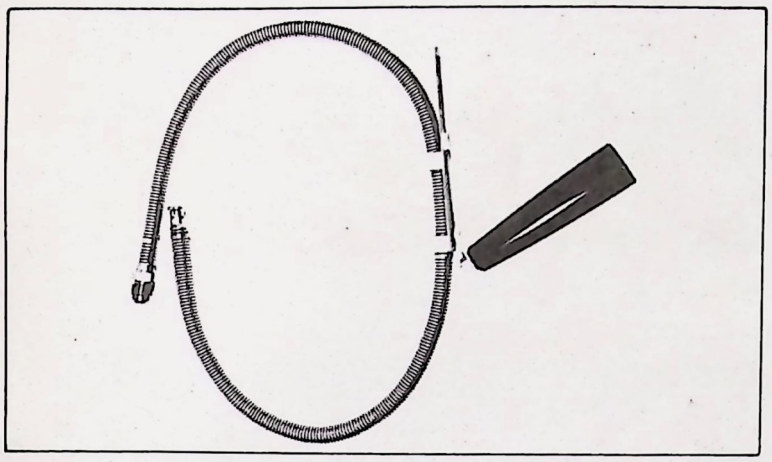


Anti-Delution Device 7009-1506
(1115-9 Only)

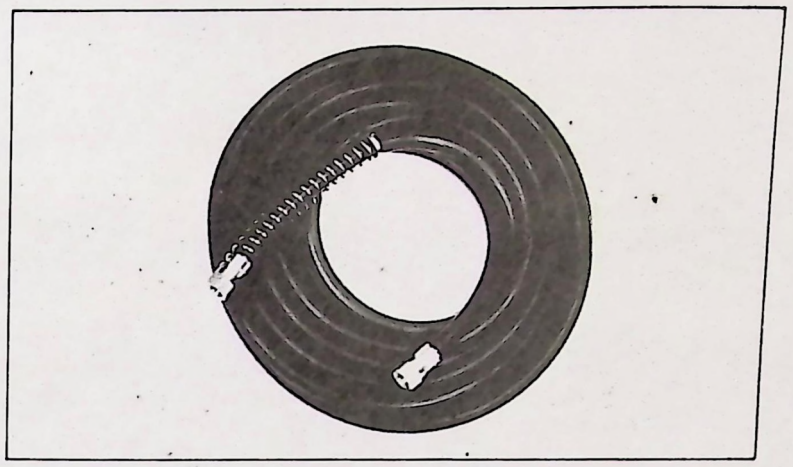


Exhaust Hose 7009-0216
(1115-9 Only)

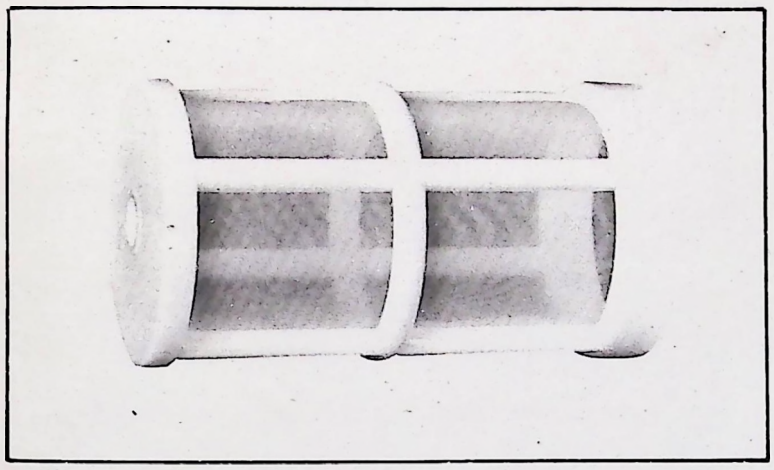
Components and Accessories



Exhaust Probe Assembly #7009-1600

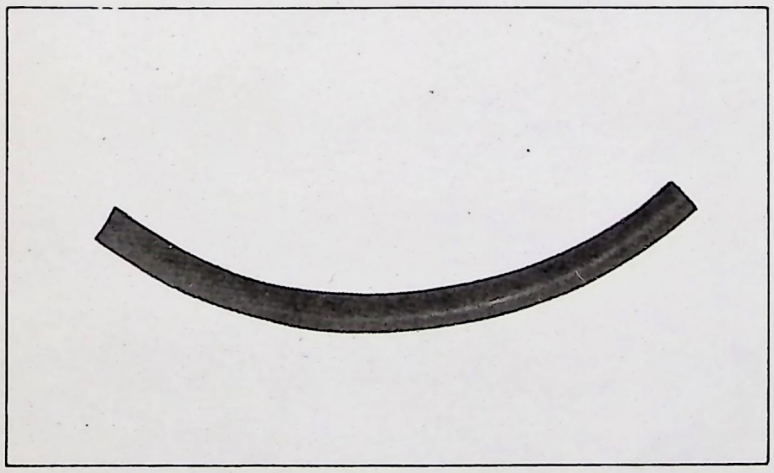


Exhaust Hose #3988-0202 (1115 only)

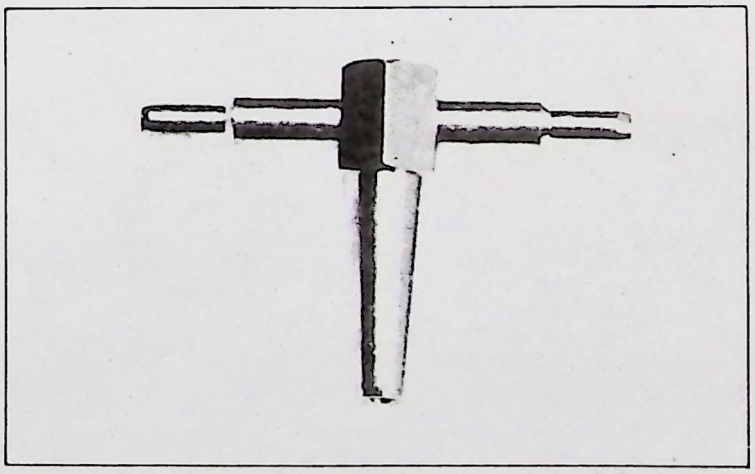


Primary Filter Element #301-926

Secondary Filter Element #301-908



6" Vacuum Hose #669-623



"T" Connector #2894-501

Sun ELECTRIC CORPORATION
ONE SUN PARKWAY•CRYSTAL LAKE, ILLINOIS 60014•(815) 459-7700

692-942-2 (2880)

Printed in U.S.A.